THE USE OF CURRENT TECHNOLOGY IN THE DESIGN AND CONSTRUCTION OF SIMPLE INEXPENSIVE TEACHER-MADE RESPONSE-CONTINGENT EDUCATIONAL MATERIALS FOR THE SEVERELY AND PROFOUNDLY HANDICAPPED POPULATION

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ABSTRACT

The passage of P.L. 94-142 has established a need for the use of new technology in the development of educational materials. This legislation states that all handicapped children are entitled to an appropriate education regardless of their disability. Because these children are so very different from the school-age population previously served, in both appearance and educational needs, their requirements in educational materials, of necessity, will also differ. This new group of students was previously excluded from public education, and therefore the methods, materials, and general technology required for their education were never developed. Now that these students are in the public schools, educators are both morally and legally bound to teach/train them in the most effective, appropriate manner possible. It is therefore the educator's responsibility to locate and /or develop such educational methods and materials as are required to meet the educational needs of this student population. The purpose of this project was to devise and construct or locate and procure a sampling of such materials applicable to the unique training needs of this special student population.

This paper presents a discussion of those teacher-made materials designed and built by the author, as well as several systems which are available at little or no expense through agencies of the government and members of the community. Simple suggestions for application accompany those devices presented. A practical/theoretical discussion was included to aid the classroom teacher in generating methods as well as designing and building materials specific to the student's particular training needs.

The educational materials of reference are of an electric and/or mechanical nature. The majority of which provided some form of feedback to the student for correct performance of the programmed task. Each device

utilized an interface (control switch) which was operable by a response well within the physical limitations of the student's disabilities.

Give me a lever long enough,

and a fulcrum strong enough,

and single-handed I can move

the world.

Archimedes

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> P.L. 94-142 requires each state educational agency to ... [adopt] promising educational practices and materials ... . because of [this] commitment to provide appropriate educational experiences to the severely handicapped population, we are finding it necessary to take advantage of advances in instructional technology in order to ameliorate the conditions of learning that have for so long hindered their achievement (Lance, 1977, pp. 94-96).

It is now widely recognized at all levels of educational policymaking that materials, media and educational technology are important in providing quality services for handicapped learners (Anderson, 1977). The recognition that available technology is an inroad to the untapped cognitive potential of the handicapped was noted by Vanderheiden et al. (1974). Haring (1970) suggested that the whole learning process could be accelerated, through the use of mechanical, electrical, and electromechanical devices. It was further stated by Haring (1970) that the use of such devices would alter the role of the teacher to include the provision of managerial and support services to the primary functions of the devices. In an undated document, Doughty added that rather than displace instructors, these training devices would supplement teachers in the manner that slide projectors and tape recorders do in the regular classroom. In summation, Haring offered that "...special educators should be ... trained in behavioral sciences, exposed to the problems of teaching, and unafraid of devices (1970, p.3)." It therefore seems imperative that for the education and future integration of the handicapped into the mainstream of society, educators and engineers must communicate and collaborate on solutions to the particular problems of the handicapped (Bernberg, 1968). "The difficult problems could be solved tomorrow, the impossible may require a few more months (Bernberg, 1968, p.695)."

In 1970 Haring stated that educational technology was being applied in

two ways: one being as a systematic manner of achieving educational objectives, and the other being tools for teaching and measurement. He suggested that the "... total gains from technology are not achieved without the full use of systematic instructional procedures (Haring, 1970, p.25)." In many cases these systematic procedures can easily be provided through the devices themselves, as was noted by Doughty in an undated document.

> ...the development of new and inexpensive methods for delivering reinforcing events, [ranging] from simple electronic toys to micro-processor-controlled stimuli. These include: small electronic musical toys, methods of providing contingent vibratory stimulation to [students], student operated tape players, modified electronic T.V. games and communication devices (Doughty, undated, p.2).

These systems can provide immediate feedback to the child in the form of reinforcement, thereby informing him about the acceptability of his performance and motivating him to produce or reproduce correct approximations of the desired behavior. Doughty proposed that through the use of such devices, students were able to more easily learn that their actions had an effect on their environments. In other words, what happens to them is, in some part governed by what is done by them (Doughty, undated, p.1). "Beyond teaching the student that he can control his environment, training the target skill, and providing reinforcement, such devices can also collect data, and automatically adjust reinforcement contingencies based upon the student's performance (Doughty, undated, p.3)." Most devices have built-in controls for variation of important parameters, which allow the instructor to program specifically for a particular student's needs. This controlled variation permits the use of fading procedures in the student's programming, as well as the flexibility to use the same device to train more than one complex

of skills. Such variability leads to more functional instructional aids. These devices are effective teaching aids because they provide the student with information about his performance, adequate reinforcement to motivate him, and flexibility enough to permit the instructor to manipulate the relevant variables (Connolly, 1968). In general then, these devices are potentially useful for training severely handicapped students. The outstanding benefit of these devices is that they provide continuous training, consistent reinforcement, immediate performance-based feedback, objective performance evaluation, and permit increased training time for the student, while making fewer demands on the teacher's time (Arroyo,1976).

The literature abounds with both simple and complex electronic, mechanical and electromechanical training devices. Driscoll (1975) discussed several of these training apparatuses which had been designed as toys . The toys were designed by a team of engineering students from M.I.T. in collaboration with the Kennedy Memorial Hospital's Occupational Therapy department to facilitate learning in a population of developmentally disabled children. "Preliminary results showed that these devices were highly motivational in teaching eye-hand coordination and perceptual motor skills (Driscoll, 1975, p,102)." Hill et al. (1968) discussed a device of their own design which provided an electromechanical means of communication to a motorically impaired child, and as a result also made formal testing of this child possible. Other devices designed to assist the nonverbal physically handicapped to communicate have been presented by LaVoy (1957), Jones (1961), Miller and Carpenter (1964), and Vanderheiden et al. (1974). In 1972, Wooldridge published the results of a study which incorporated the use of a device for training control of head position in cerebral palsied children. Ashton (1973), Mavilya and Mignone

(1977) noted the existence of toys which were activated by sound and could therefore be used to reinforce vocalization in deaf or developmentally delayed children. Other investigators have reported devices of greater sophistication, which were used to aid the disabled in communication and environmental control (Arroyo, 1968: Copeland, 1974). One author in particular discussed and illustrated a number of interfaces ("off/on" switching systems sensitive to specific behaviors of the operator) which permitted the disabled person to control output devices through a variety of potential residual abilities including: eye movement, respiration, and skin contact (Copeland, 1974). Several electronic and electromechanical forms of recreation were presented by Sheredos (1973). Although these "games" were designed for disabled veterans, they could be adapted for use by young disabled students. Sheredos' (1973) discussion included an electronic "pong" game and a pinball game operated by interfaces sensitive to chin movement and pneumatic pressure ("puff and suck") respectively. These interfaces, and those noted by McCann et al. (1966), Lipskin (1970), Foulds et al. (1973), Copeland (1974), Wethered (1976), and Tawney (1977) may be prescribed for the individual student, based upon his disorder and/or residual abilities, as was suggested by Wethered (1976). "Most severely [physically] disabled [students] are able to move some part of their bodies, if only a fraction of an inch (Sampson,1970,p.99)." Therefore, through appropriate interface selection, that residual responding ability may be tapped electronically to provide control of anything desired/imagined by either the student or teacher (Sampson, 1970). The student needs only one controlled response to activate an interface ("off/on" switch) which in turn can operate any conceivable output device (Jones, 1961; Miller and Carpenter, 1964). As a result of this technology, training, communication, and environmental control are available to students having any of a wide variety of disabilities.

Because of the frequent need to adapt, alter or redesign interfaces specific to the disabled person's needs, there are no "standard" interfaces, only basic switches from which to build the required unit (Miller and Carpenter, 1964; Kavanagh et al., 1966).

It was the unstandardized nature of this art that prompted this project. The devices designed and procured for this "demonstration project" were selected as representative of the technology needed and readily available to the classroom teacher. The devices can be adapted to the student's particular needs and range in price from free to inexpensive. The purpose of this project was to provide the teacher of the disabled student with a survival kit, containing basic information and techniques for designing, constructing, and procuring training aids for their students.

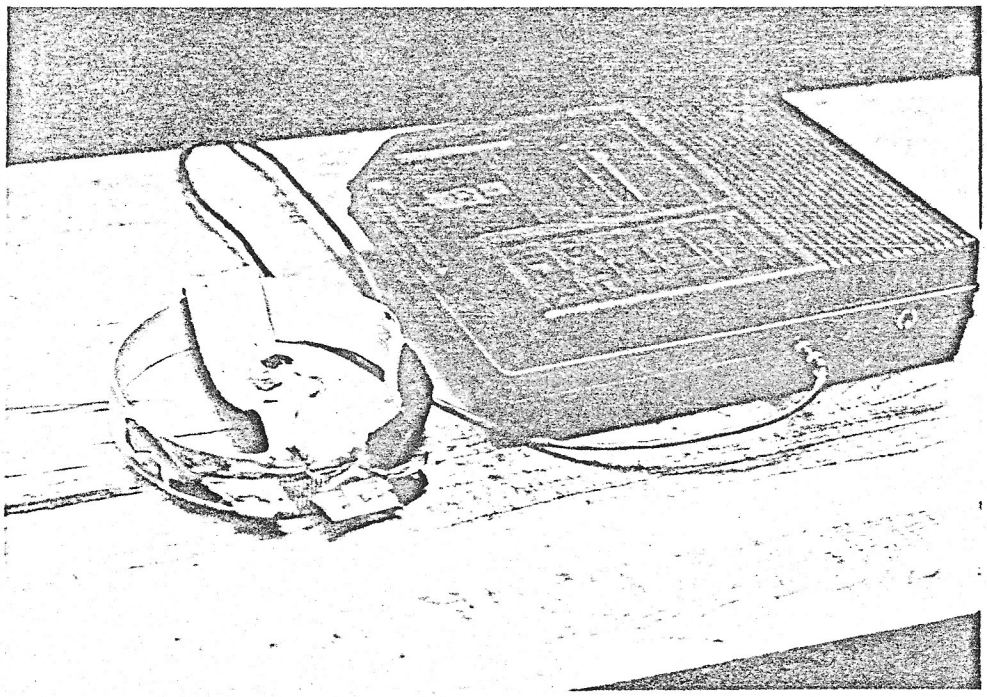
It is with an eye to economy and the teacher's materials budget that the author has brought the following sources of free materials to light. The sources presented are the Library of Congress, Division of Blind and Handicapped Services. This division offers a variety of adaptive materials which allow the blind and/or physically disabled to enjoy books, periodicals, and newspapers. These services are available to disabled persons individually and as classes in training centers. Although the uses suggested in this paper are not those for which the devices were intended, they may be of more use in the education of the severely disabled than they are in allowing a disabled adult to read the paper. The Library of Congress is pleased to provide these devices to anyone who requests them for a disabled person, even if they are not to be used with the intended materials. The generative teacher can find a variety of training uses for these materials, beyond those suggested by the author. The generic term used by the Library of Congress to describe any device which brings the content of printed matter to the blind or disabled in a form useful to them, is Talking Book. There are two types of Talking Books which

are currently available, they are a cassette tape player and a record player.

Tape Player: This tape player was used by the author as a form of reinforcement with a variety of behavior specific interfaces. This was done by plugging the interface (adapted "off/on" switch) into the remote "on" jack of the tape player. In essence the interface was substituted for the original "off/on" switch. Although the tape player has to be left in an "on" position, it will not operate until the student turns the interface "on" also. The Library of Congress will also supply "extenders" for the buttons of the tape player which permit a greater surface area with a reduced pressure requirement for activation. The tape player and record player are presented in Figure 1.

Record Player: This device allows for the attachment of either a set of headphones or a pillow speaker which permit the student to individually monitor the output of the record player and not disturb the other students. The private listening feature gives the teacher a potential reinforcer to individual students. The pillow speaker can be mounted in the back of a chair to increase its special nature, or it can be used, as intended, with bedbound student. An especially attractive feature of the record player, is that it can be ordered with a remote control switch. This switch is sensitive to skin contact, no pressure is required for activation. This is of great value in training a variety of skills, ranging from pointing for early communication board skill training, to teaching concepts of environmental control. Both the tape player and record player are available on a loan basis to either classes of or individual disabled students. If damaged, the Library of Congress will repair or replace the unit at no charge. Both the tape player and record player are available at no charge from the regional offices listed in Appendix A.

The Telephone Pioneers are another fine source of free materials and general assistance. They are a group of current and past employees of the Telephone Company,



(a)

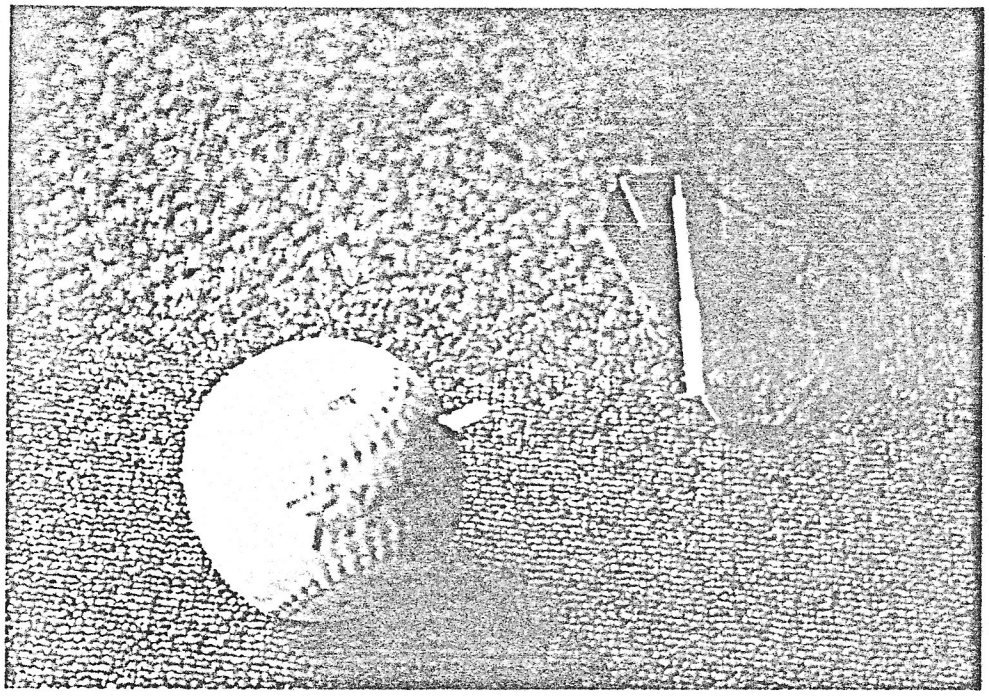
(b)

Figure 1. Photographs of the Talking Book Machines: the tape player (a) and the record player (b). The tape player is shown with the head position trainer which is not an option available from the Library of Congress - Division of Blind and Handicapped services. The record player is shown with the pillow speaker (front of b) and remote control switch (two objects seen at the right of b).

who dedicate their volunteer time to the service of their community. Each community has its own chapter, and each chapter has certain "pet" projects. The particular projects to be presented in this discussion are the audio ball and the VOX relay. The procedure for contacting the Telephone Pioneers in your community and the sources of the audio ball and VOX relay are contained in Appendix A. Figure 2 presents photographs of the audio ball and VOX relay toy.

Audio Ball: This device is built into a regulation size soft ball, and emits an intermittent, high frequency pure tone. It can be used to train auditory/visual localization, eye-hand coordination, visual or auditory tracking, and object permanence. It is a toy which stimulates curiosity environmental interaction, general motor activity, or acts as a reinforcer for task completion. Although the audio ball was intended for use by the blind, it is available to individuals having any disability, and to centers serving any population of disabled individuals.

VOX Relay: This simple electronic interface is activated by sound and therefore allows for operation through vocalization or sound production. The "Pioneers" will donate the circuitry, a stuffed animal of the student's or instructor's selection, and the time required to implant the electronics into the stuffed toy. The end result is a toy whose eyes (lights) blink off and on in response to the student's vocalizations. Although these toys were intended for use by the deaf, the pioneers will provide them to hearing children with disabilities. The uses of these VOX (voice activated) relay toys with handicapped and delayed students overlap those for the deaf, that is reinforcement for vocalization. In addition, however, the VOX toys provide feedback from the environment, showing the child that his "sounds" have an effect on his environment. This is a basic function of communication. If our vocalizations or words had no influence or effect upon our environment, it is unlikely that much communication/speech would be generated by adults. The VOX is helpful in



(a)

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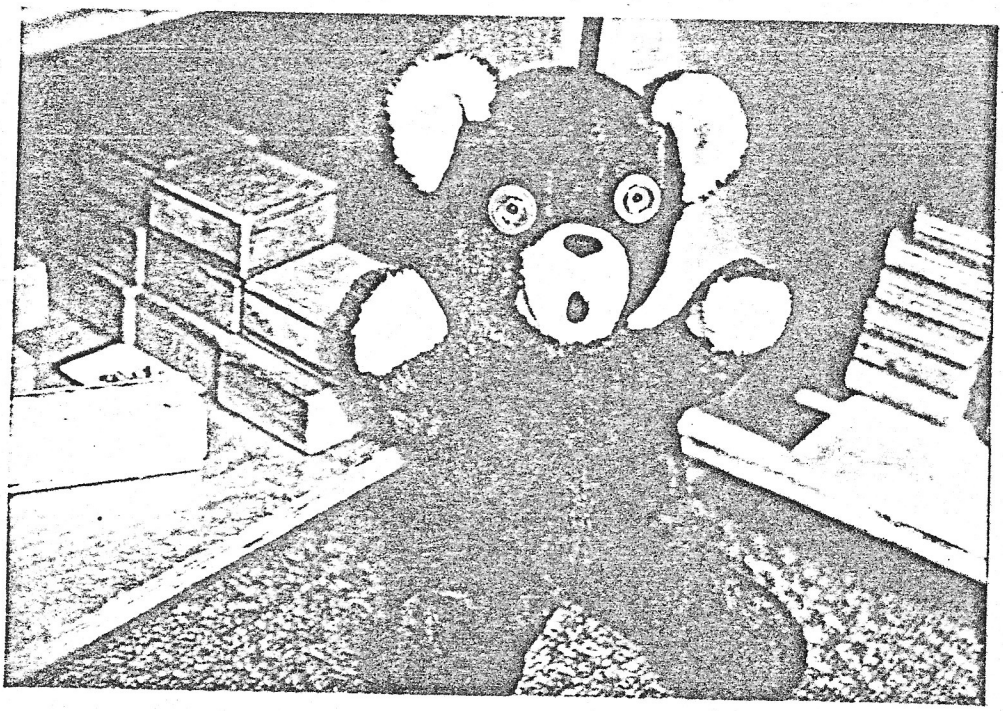


Figure 2. Photographs of the Audio Ball and recharger (a) and the VOX relay (built into a teddy bear) (b) available from the Telephone Pioneers.

teaching this concept, so crucial to the whole act of communication, in addition to being a very novel reinforcer.

The Telephone Pioneers also perform projects of a special nature, ranging from constructing classrooms and landscaping day care centers for the handicapped to raising funds for an individual student's life support equipment. There are no costs associated with the services of either the Library of Congress or the Telephone Pioneers, which provides the creative instructor the means to acquire materials for training at no expense.

Another useful source of training materials is the IBM Corporation. Their services, however apply to a much smaller segment of the disabled population. That portion of the disabled is the student who can type using an electric typewriter. It is to these persons that IBM offers reconditioned typewriters at their trade-in value. IBM also has arm rests, keyboard templates, continuous roll perforated paper, and cogwheel rollers to feed the paper into the machine. All of these adaptations are available to the disabled person at cost.

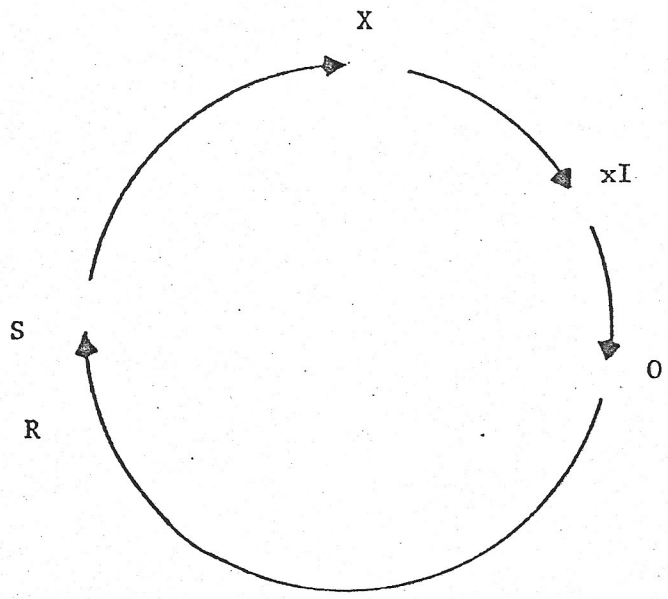
In addition to those devices commercially available and those provided at no cost through federal and community sources, there are a large number of simple electric aids which the motivated teacher can easily design and build specifically to meet the student's needs. The classroom teacher may, in fact, be the most logical person to build or mediate the building process because of her knowledge of the student's abilities, disabilities skill levels and skill needs. With this knowledge she can propose a means of motivating the student to move from his current level of functioning to successful acquisition of new responses. The instructor may wish to build the materials personally or to communicate the technological needs to one who can and will design and construct them. In either case it is important that the instructor become aware of the

process involved in interfacing a student to a system, to provide maximum benefit to the student and receive maximum utility from the device.

Principles of system design:

The student must, in effect, be viewed as a component to be fitted into the system, having both effective inputs (reinforcers) and forms of output (responding abilities). The interfacer's job is to find a device which has an output which matches the student's input need (acts as a reinforcer), and an input interface which is activated by a response similar to the student's output mode. In other words the teacher must isolate a response which the student can currently control or needs to learn, locate or design an input interface which is sensitive to that response, and find a reinforcing consequence which is operable contingent upon interface activation. The reinforcing quality of the output may be sensory stimulation, the novelty of environmental control, or that the device performs some functional task for the student. The system which is produced should function somewhat as is seen in Figure 3. In this figure the student (S) performs X behavior which activates the X sensitive interface (xI), and the interface (xI), in turn, activates the the output (O), which reinforces (R) the student (S). The result is a feedback loop wherein the student is informed of the acceptability/quality of his every response through direct feedback from his environment.

In terms of specific application of the interfaced system, the interface should be used to either permit the student to manipulate some part of his environment through an existing action scheme, or to establish a new behavioral response in his repertoire. The interface may be applied to a response that the student has under adequate control, in which case the device may be used to provide the student with additional control of his environment. This environmental control allows the student to have some independence from others,



S - Student
X - Student response
xI - Interface sensitive to the student's response
O - Output of the device
R - Reinforcing effect on the student

Figure 3. Feedback loop incorporating the student as a component of the system.

to develop self confidence and a concept of himself as an agent, as well as his concepts of means-ends, and cause-effect, the latter two concepts being prerequisites to effective communication. The environmental control provided, may only be the operation of a tape player, film strip projector, motorized mobile, or a communication system, but it provides the student just that little bit more independence and experience. The interface may also be used to programmatically develop new motor skills through a fading of contingencies for interface activation (reinforcement). Tables 1 and 2 provide hierarchies of questions which the teacher must ask herself when designing either of the two, above mentioned, system types. Upon close examination, it will be noted that the sequencing of the questions in each hierarchy reflects the different emphasis in each system type. The hierarchy seen in Table 1 is directed to providing environmental control and therefore focuses on the device output/ student input (reinforcement) portion of the diagram seen in figure 3. The hierarchy presented in Table 2 is directed to the development of new student output forms, and the delivery of reinforcement is almost of secondary importance. In both cases, however, a similar interfacing procedure is followed, that is, the primary concern is the student's output (response) or his input (reinforcement). Once the primary concern is isolated, the questions are directed towards the production and conversion of the student input or output into and out of an electrical and/or mechanical form. The interface and the reinforcer of the feedback loop (Figure 3) are less immediately flexible in that they are constrained by the student's initial responding ability and reinforcement preferences.

The reader has thus far been exposed to the rationale for, and some applications of the technology involved in educational materials for the handicapped. It seems appropriate that he should also be made aware of some of the simple

Table 1. Hierarchy of questions which the teacher must ask in order to interface the student into a system which permits environmental control.

1. Student Input (R)*
   What element of the environment does the student want or need to operate?

2. Device Output (O)*
   How can that element of the environment be placed under electrical, mechanical, or electromechanical control?

3. Student Output (X)*
   What response does the student have under reliable control, for interfacing into the system?

4. Device Input (xI)*
   How can the student's controlled response be changed into an electrical signal? That is, how can it be interfaced into the output mode?

* Refer to Figure 3 for the function these elements perform in the feedback loop.
  - R - Reinforcing effect on the student
  - O - Output of the device
  - X - Student response
  - xI - Interface sensitive to the student's response

Questions 1 and 3 are the primary responsibility of the teacher, they are essentially, what does the student need to do and what can he do.

Questions 2 and 4 may be deferred to someone having some knowledge of available electrical equipment and its workings.

Table 2. Hierarchy of questions which the teacher should ask in order to interface the student into a system which provides reinforcement and is used for the development of new skills.

1. Student Output (X)*	What skill has been difficult to train through typical methods of training?
2. Student Output (X approximation)	What is the closest approximation to the desired skill which the student produces?
3. Device Output (R)*	What does the student find reinforcing? (ie. auditory, tactile, or visual stimulation)
4. Student Input (R)*	How can the appropriate reinforcer be produced mechanically, electrically, or electromechanically?
5. Device Input (xI)*	How can the X approximation (currently produced) be used to operate the device and then gradually altered until it requires the actual X response to operate it?

* Refer to Figure 3 for the function these elements perform in the feedback loop.
  - X - Student response
  - R - Reinforcing effect of the device
  - xI - Interface sensitive to the student's response

Questions 1, 2 and 3 are in the domain of the teacher, while questions 4 and 5 require some knowledge of available electrical equipment and its workings.

building blocks involved in this process, prior to seeing samples of teacher made materials.

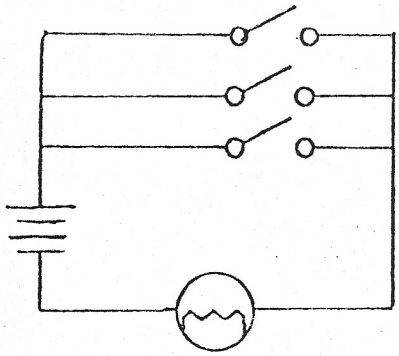
Basic Electrical Considerations

At a very basic level, electric devices do not work without electricity, and to provide that electricity one must have a complete circuit or path from a power source to the device and back to the power source. The complete circuit is an unbroken path in which the electricity can circulate. This pathway is broken and reestablished by an "off/on" switch. For example, the function of a light switch is to break and complete the path from the power pole (outside your house) to the light bulb and back to the pole. When a complete circuit is established, the electricity passes through all of the components which are connected into the circuit, providing them with the electricity they require for operation.

There are two basic relationships which components in a circuit may hold to one another. These relationships permit the instructor to perform a variety of different functions with the same basic components. The components of a circuit can be arranged in either parallel or in series (or in a combination of parallel and series).

Parallel: This method of connecting two or more components into an electrical circuit permits electricity to pass through all of the components regardless of the status of the other components. In Figure 4, example (a) illustrates three switches connected in parallel to a light bulb. Any of the three switches will operate the light bulb whether the other two switches are open or closed. In other words any of the switches, individually, can form a complete path from the battery to the light bulb and back to the battery. Another application of a parallel circuit is shown in example (b) of Figure 4. In this particular application, three light bulbs have been connected in parallel with a switch. If the switch closes (or completes) the circuit, all of the

(a)



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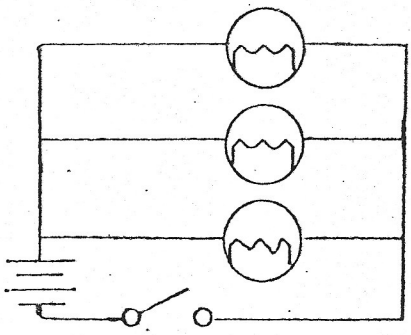

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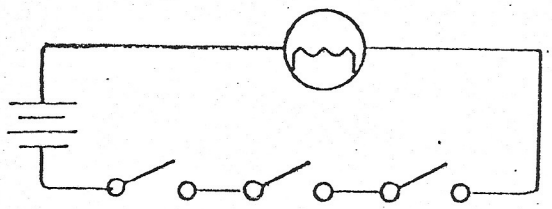

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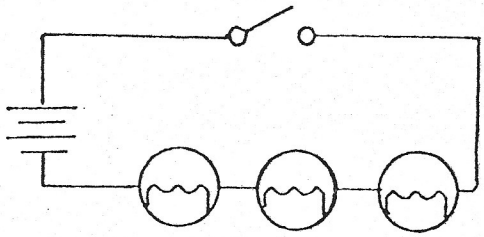


- light bulb

- switch

- battery

Figure 4. Examples of parallel (a and b) and series (c and d) combinations of light bulbs and switches.

bulbs will be illuminated. In the event that one or two bulbs are "out", for example, broken or removed, the remaining bulb or bulbs will still be illuminated. This method of connecting components is frequently used with Christmas tree lights so that one "bad" bulb will not stop the electricity from reaching the other bulbs. Each component in a parallel circuit, therefore, has its own private connection to the switch and power supply, and is independent of the status of the other components in the circuit.

Series: In this method of connecting two or more components of an electrical circuit, the flow of the electricity is dependent upon the proper functioning of each component. Figure 4, examples (c) and (d) present serial connections of three switches and three light bulbs respectively. If one of the components connected in series fails to permit electricity to flow past it, the path of the electricity is broken and the remaining components will not receive the electricity which they require to function. In example (c) of Figure 4 the three switches must all be closed to complete the circuit and activate the light bulb. If one switch remains open the circuit will not be complete, and the electricity will not reach the bulb. Example (d) of Figure 4 illustrates three light bulbs connected in series with one switch. When the switch is closed, the three bulbs will illuminate, but if even one bulb is "out" of the circuit, the remaining bulbs will not light up. The components of a series circuit are therefore dependent upon the functioning of the other components, with which they are in series.

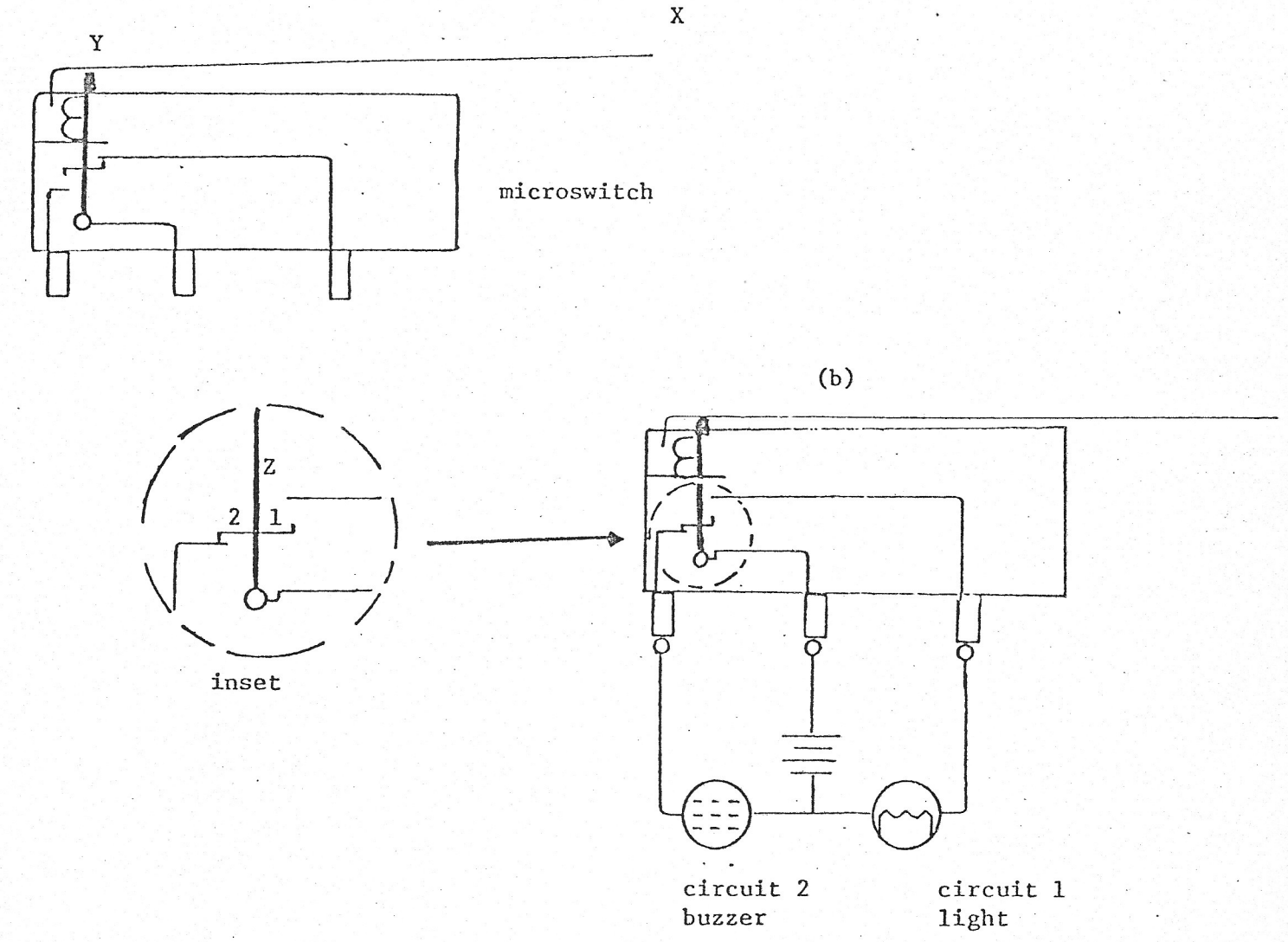
The parallel circuit allows the student to receive several reinforcing events for a single response (see example (b), Figure 4.), it also permits him the option of several switches to choose from for operation of the given device (this may be seen in Figure 4, example [a]). The series circuit (seen in Figure 4, example [d]) permits the student to receive several

reinforcing events contingent upon a single response, as did the parallel circuit seen in Figure 4, example (b), assuming that all components are in working order. The advantage of the series circuit is that it permits the teacher to require several concurrent responses for reinforcement (as is seen in Figure 4, example [c]). This arrangement was used in the head position trainer to be discussed in greater depth in the teacher made devices section of this paper. In this device there were several position sensitive switches which require compliance in four parameters of head position in relation to midline before the student received reinforcement.

The switches most commonly used by this author for interfacing students to output devices are the microswitch and mercury switch (seen in Figures 5 and 6 respectively). They are generally adaptable to the process of interfacing, because of their size and sensitivity.

Both the microswitch and the mercury switch are momentary contact in nature. That is to say that they only complete the circuit while the student is operating them correctly through application of pressure or by maintainance in the desired position respectively. In both cases, their operation permits electricity to flow, but once the student removes the pressure or moves from the desired position, the switch breaks the circuit again.

Microswitch: This switch is operated by the application of pressure to button "Y", either directly or through the use of lever "X" (as seen in Figure 5). This action causes the button to be depressed and resultantly lowers the contacts. These contacts (see Figure 5 inset) are solely responsible for breaking and completing one of the two possible circuits available with the microswitch. The inset illustrates that the depression of button "Y" moves rod "Z" down, the contact points "1" and "2" move down



- light bulb

- buzzer

- battery

- spring

- connection point

Figure 5. Schematic representation of the functioning of the microswitch (a), included is an inset of the switching action, and an application (b).

with rod "Z". In moving, contact point "1" is broken from circuit 1, and contact point "2" is connected into circuit 2. The performance of this switch can be either normally "on" (circuit 1), or normally "off" (circuit 2) when in the resting, unactivated position. This switch also permits the user to change the flow of electricity from a device in circuit 1, to a device in circuit 2. This particular application is depicted in Figure 5, diagram (b). It can be seen that depression of button "Y" breaks the connection with circuit 1, and establishes a connection with circuit 2. When the pressure is removed from lever "X", rod "Z" is returned to its original position by a spring and resultantly circuit 2 is broken, while circuit 1 is reestablished. As a further example of the function of the microswitch, Figure 5 illustrates both the resting state (a) and the activated state (b) of the microswitch. In Figure 5 (b) the switching action is also illustrated. The function of circuit 1 is the activation of a light bulb, and the function of circuit 2 is the operation of a buzzer. In the resting state (Figure 5[a]) circuit 1 would permit the light bulb to receive electricity, while in the activated state (Figure 5 (b), and inset) the electricity flows into circuit 2 and resultantly the buzzer. In the resting state the light would be "on" and the buzzer would be silent, while in the activated state the buzzer would be activated and the light would be "out". In most of the applications for which the teacher may need to use the microswitch, she will probably only require one circuit, that being either normally "on" or normally "off". The microswitch, then, has three functions; transfering power from one output device to another, temporarily stopping an ongoing phenomena, and temporarily activating a phenomena. The phenomena of reference being that output needed for the student in question, for example: light, sound, vibration, or music. The

fact that the microswitch is sensitive to pressure, permits the teacher to apply it to almost any pressure producing behavior. Some potential applications might be the development of a pointing response, a grasp/squeeze response, the increase of "in seat" behavior, "feet on the floor" behavior, or even a "hands on the desk" behavior. In short, the microswitch could be used to develop a variety of new skills or extinguish maladaptive behaviors through the reinforcement of incompatable skills.

Mercury switch: As seen in Figure 6, the mercury switch consists of a hermetically sealed glass tube containing a drop of mercury and two metal posts which exit at one end. The mercury switch is a position sensitive switch by virtue of the fact that mercury is a liquid metal. It therefore is both heavy and a conductor of electricity; this means that when the position of the tube allows gravity to pull the drop of mercury into contact with the two metal poles, it completes the circuit and resultantly electricity is permitted to flow. Conversely, the circuit is broken when the position of the tube causes the drop of mercury to roll away from the two metal poles. Figure 6 illustrates the operation of the mercury switch in both the "off" (a) and "on" (b) positions. Because the mercury switch is sensitive to its position in space, it can be used easily for monitoring the position of a variety of the student's body parts. This may be of importance in training the student to hold his head in an upright position, or to monitor/modify the the angle of arm elevation (for example to reduce some self-stimulatory or self-abusive arm behavior).

Jacks and Plugs: This two component unit provides the teacher with the option of interchanging interfaces and output devices. These units are used as the connection between home stereos and earphones. Jacks and plugs

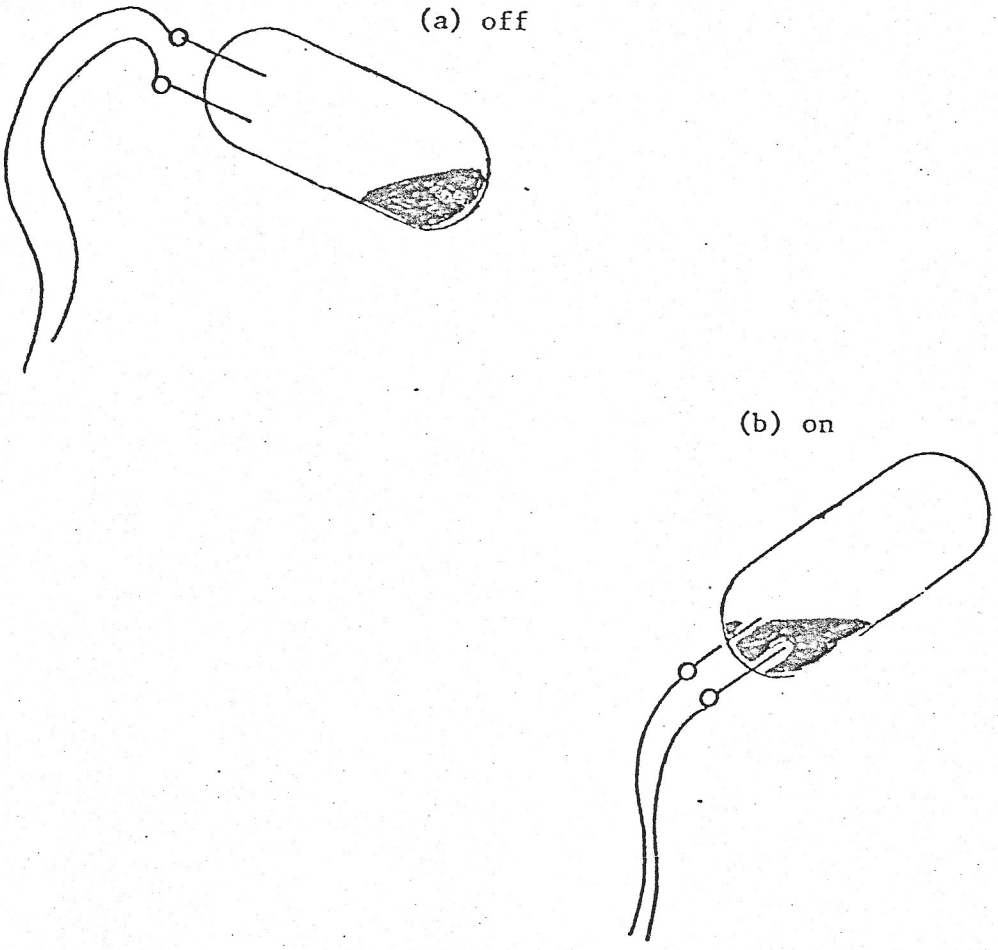


Figure 6. Illustration of the mercury switch in both the "off" (a) and "on" (b) positions.

present the option to use one output device with several students, each of whom needing a different input interface specific to their particular disorder and training program. Figure 7 illustrates the functioning of the plug (a) and jack (b) as well as depicts their functional relationship to one another (c). In essence the jack and plug unit permit the teacher to have a complete circuit and still have the option to separate and reconnect the circuit's components without having to cut and solder wires.

The relay and solenoid are two components which permit indirect switching. This is important in that the needed output device may require more voltage than the teacher would like the student to have direct contact with. The indirect switching is performed through the use of electromagnetism. Both the relay and solenoid on the principle of electromagnetism, which is the force generated around a wire when electricity is passed through it. When the wires are wound around a spool the strength of this electromagnetic force (EMF) is greatly increased. The EMF arises with the onset of the flow of electricity and disappears when the electricity stops flowing. Although on a much smaller scale, the relay and solenoid operate on the same principles of electromagnetism as do the large magnets used to lift, move and drop scrap metal and cars in junk yards. The large scrap movers pick up their load when the electricity is allowed to flow through their coils of wire and generate electricity, the load is then dropped when the electricity is stopped and the EMF resultantly disappears. The relay and solenoid use their EMF to activate a switch which is directly linked to the output device. In other words the student activates the relay/solenoid through his interface, and it activates a switch which activates the output device. By using such intermediate switches as the relay and solenoid, the

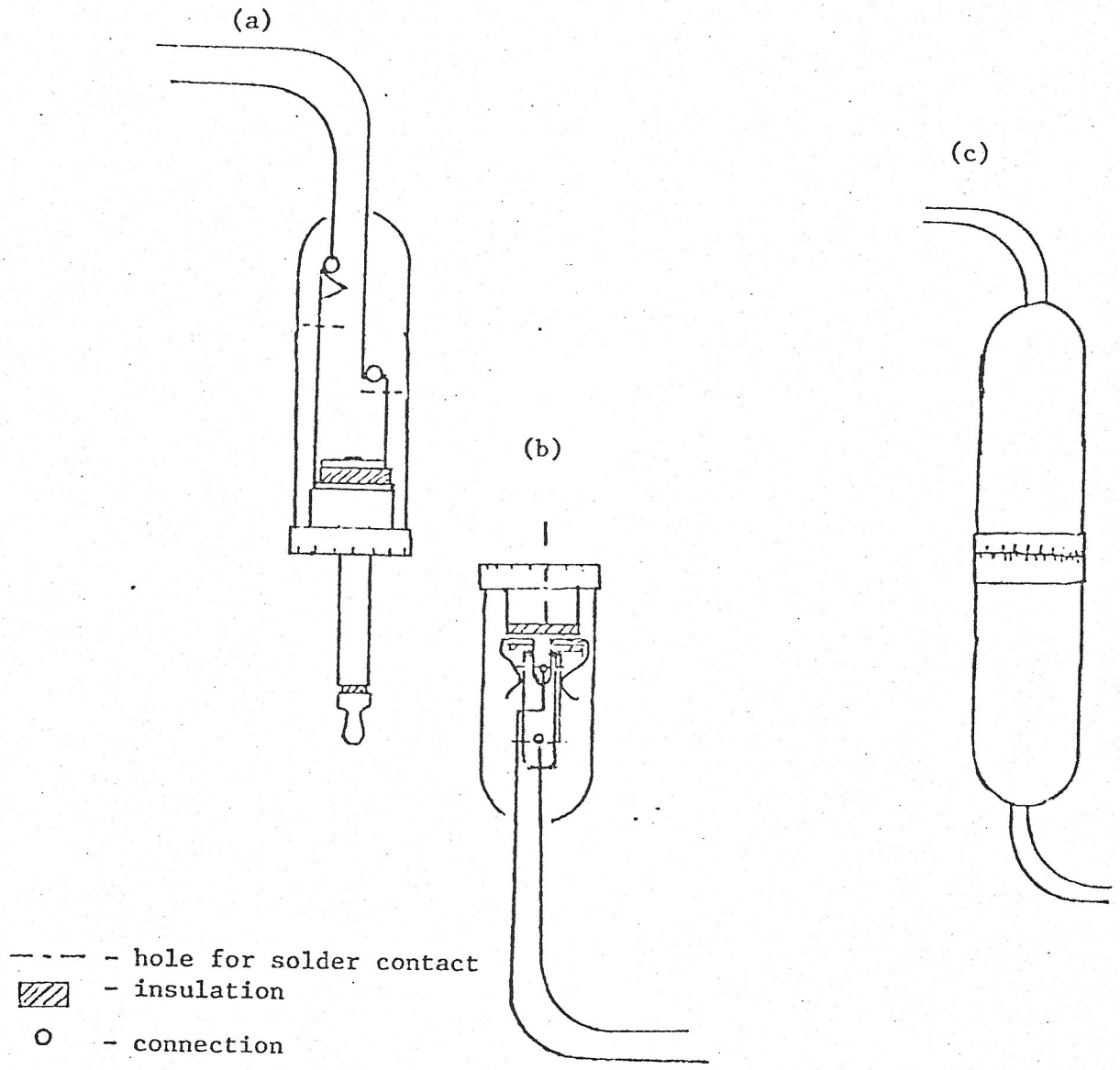


Figure 7. Cut away views of a plug (a) and jack (b) and their functional relationship (c) to one another.

student is safely isolated from any direct contact with a potentially hazardous power source needed for the required output device.

Relay: The relay seen in Figure 8 functions in a manner similar to the microswitch presented in Figure 5, however where the pressure applied to the microswitch is generated from a human source, the relay generates an EMF to pull the points into contact for completion of the circuit. The EMF is applied at point "a" of the relay seen in Figure 8 (b), and the connection is made at point "c" of the same diagram. As with microswitches, the relay can operate two functions alternately, one normally "on" "b" and the other normally "off" "c" (as seen in Figure 8 [b]). Figure 8 (a) shows an application of the relay seen in diagram (b).

Solenoid: The solenoid utilizes the EMF which it generates to move an iron bar which is suspended through the center of it's wire coil (see Figure 9 (a), the movement of the iron core, in turn, operates another switch, for example a microswitch (see Figure 9 [b]). The use of the solenoid also mechanically isolates the student from direct contact with any large voltage.

Remote control: To further insure the safety of the student, the relay and solenoid may be operated via remote control, as is provided with the talking book/record player discussed earlier. In addition to protecting the student, this unit protects the output device from the student and also permits the student with the mobility not available with the direct connections used in the other systems. The use of remote control may require the assistance of an electronically sophisticated consultant. The parts for the remote control unit may be taken from a used remote control toy, and then adapted into the system needed by the student. In essence the transmitter should be connected to the interface by a jack/plug unit, and the receiver should be plugged into the output device, or attached via a relay or solenoid.

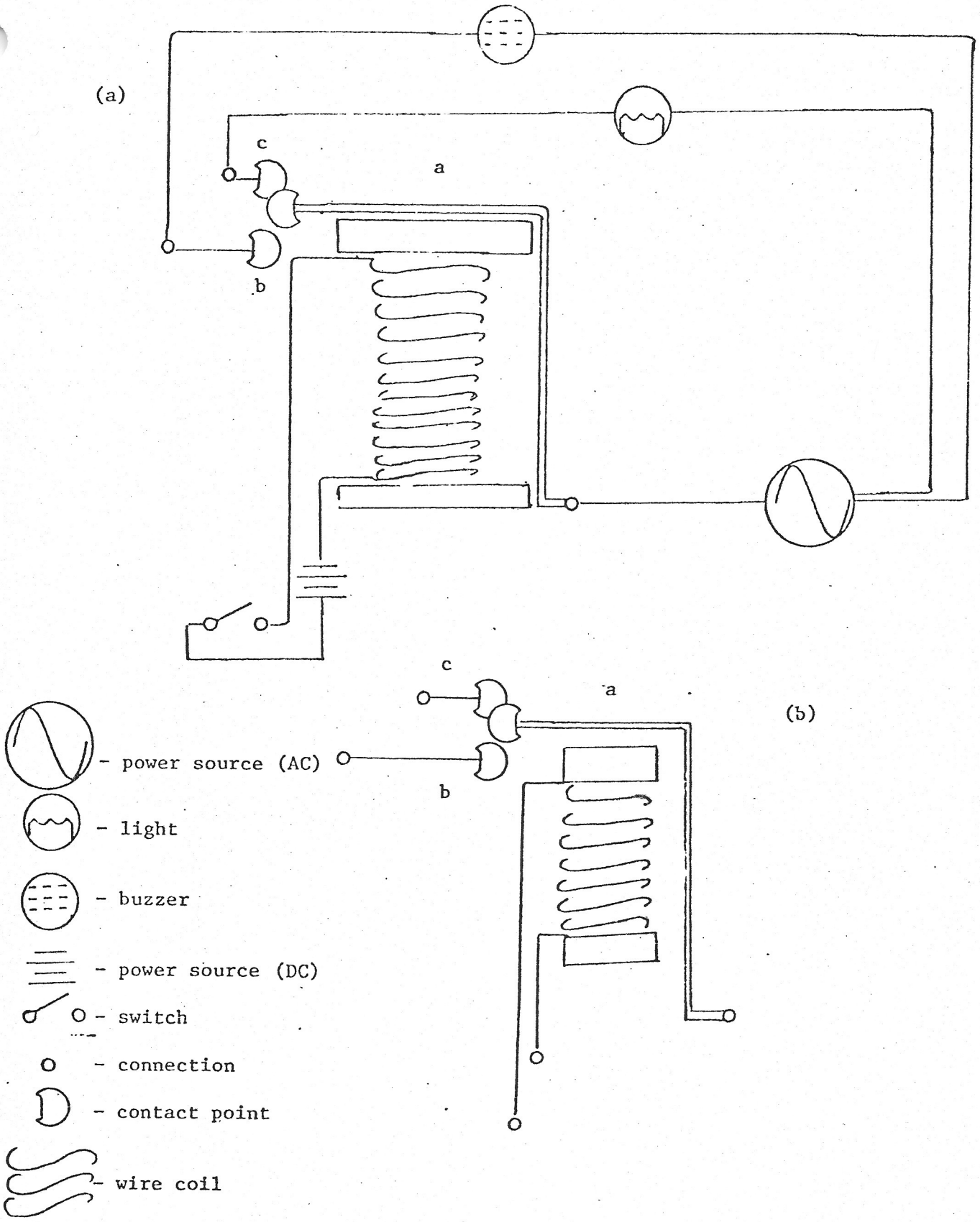


Figure 8. Diagram of the relay in application with a light and buzzer (a), and in isolation (b).

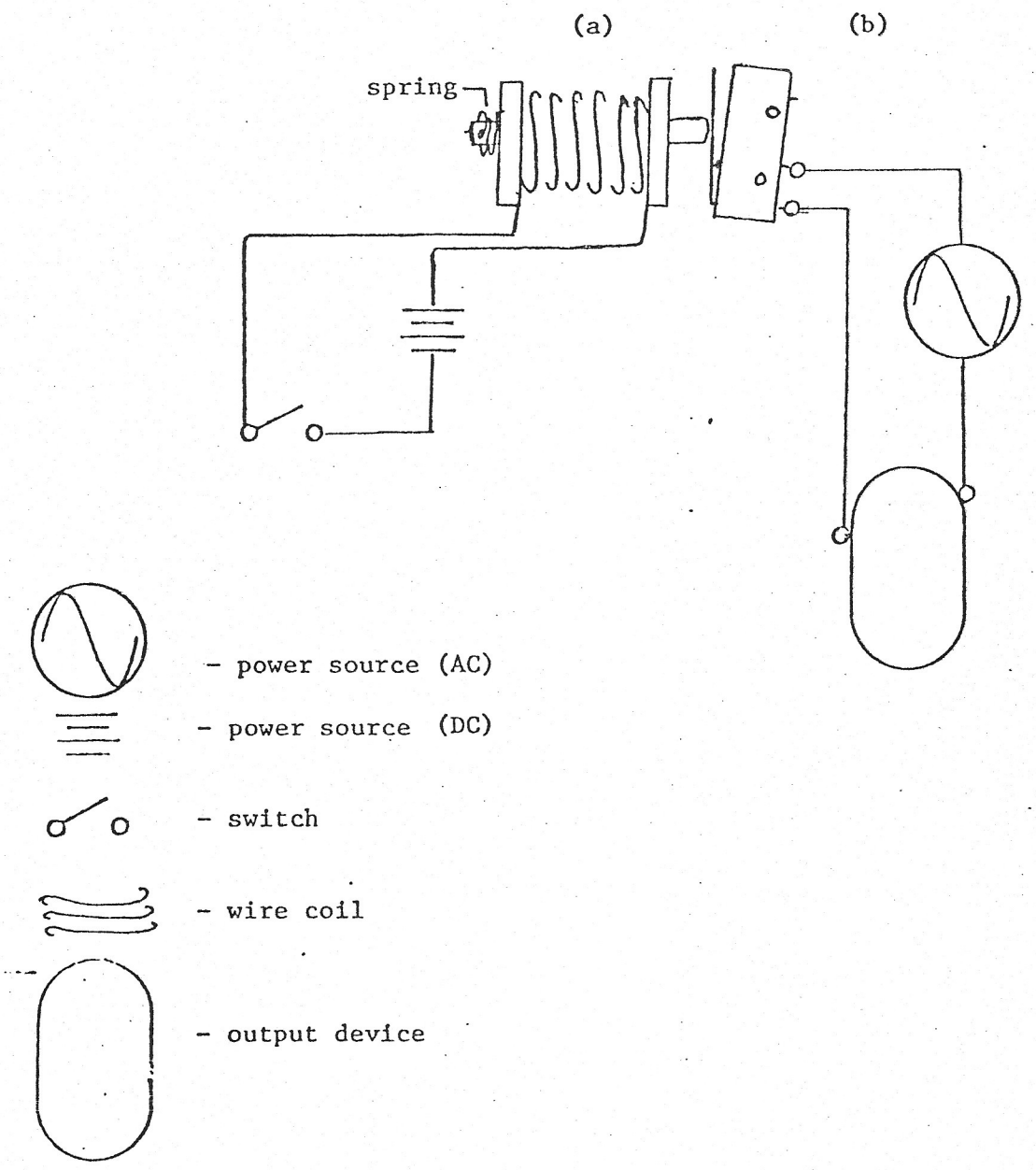
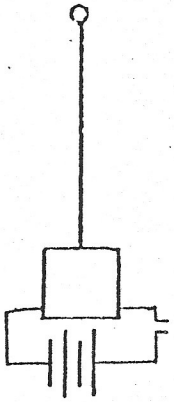
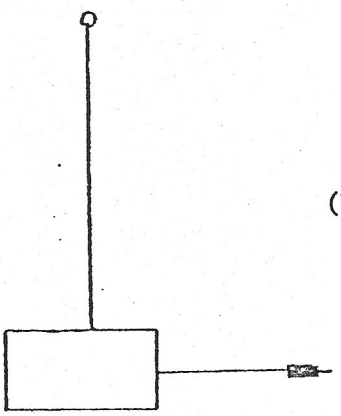


Figure 9. Diagram of a solenoid (a) mechanically operating a microswitch (b) and an output device.

This arrangement is presented in Figure 10. Appendix B provides general sources for microswitches, mercury switches, jacks, plugs, relays, solenoids, remote control units, and across the counter consultation. Appendix C contains information on related information on related periodicals, references, and commercial equipment for the reference of the reader. The preceding electronic building blocks were used in the construction of the following input interfaces and output devices designed and built by the author.



(a)



(b)

- plug

- jack

- power source

Figure 10. Diagram of a transmitter into which an interface may be plugged (a) and a receiver which plugs into an output device (b).

TEACHER-MADE

DEVICES

INPUT INTERFACES

TOUCH SWITCH

Device name: Touch Switch

Rationale: This interface was designed to operate a variety of functional and/or reinforcing output systems. A photograph of the touch switch is presented in Figure 11, and photographs of the touch switch in application two output devices are provided in Figure 12. The initial uses for the touch switch at the Debbie School were for training a pointing response (faded from an initial gross reaching response), training initial symbol/referent relations, means-ends and cause-effect relationships for a communication board based language program, as well as for providing students with experience in controlling their environments. The touch switch was developed as a specialized classroom material for helping students to acquire new skills, or more fully use those skills currently present.

Operating principles: The touch switch contains a microswitch, which is mounted just below the hinged lid. When pressure is applied to the lid (top surface of the small box seen in Figures 11 and 12 as well as diagrammed in Figure 13) the lever of the microswitch is deflected and the output device is turned "on". The output devices used with the touch switch were the Library of Congress tape player and the Rotary Dial Communication Device (discussed below) seen in Figures 12a and 12b.

The touch switch was first used in the pointing response training program. It allowed for the shaping of a gross reaching response into a refined pointing response in a limited number of trials. This was done by placing this interface between the student and the brightly colored Library of Congress tape player. The touch switch/interface was triggered when the student reached across it to obtain the tape player, for which the student had been primed by seeing and hearing it in operation at an earlier time.

The music or sounds produced by the student's contact with the interface was used as a reinforcer. Through practice, all of the students involved in this program learned to operate the tape player via the interface. One student was even able to generalize this ability to the use of buttor on the tape player for operation. The tape player was then moved well out of the student's reach and a "symbol" for music was placed on the lid of the interface. The next phase of this program was to remove the tape player from the student's visual range, and finally to place the music symbol on a communication board and upon correct pointing by the student, the teacher operated the tape player as reinforcement. At this point in the training program other symbol/referent relations were introduced. The materials for construction of this interface (the touch switch) are listed in Appendix D.

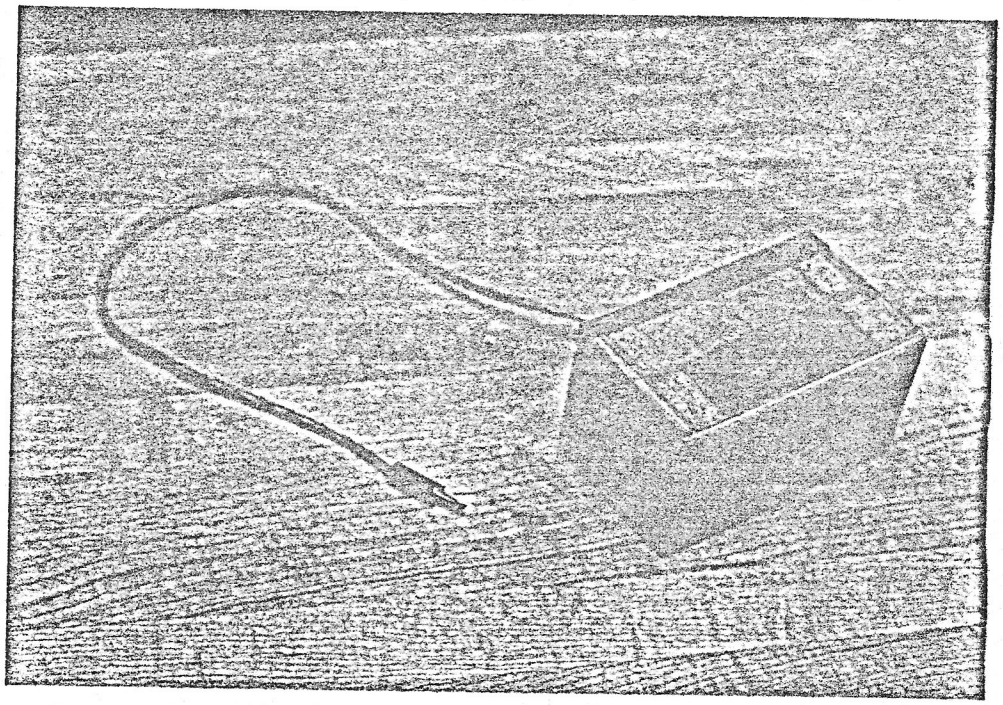
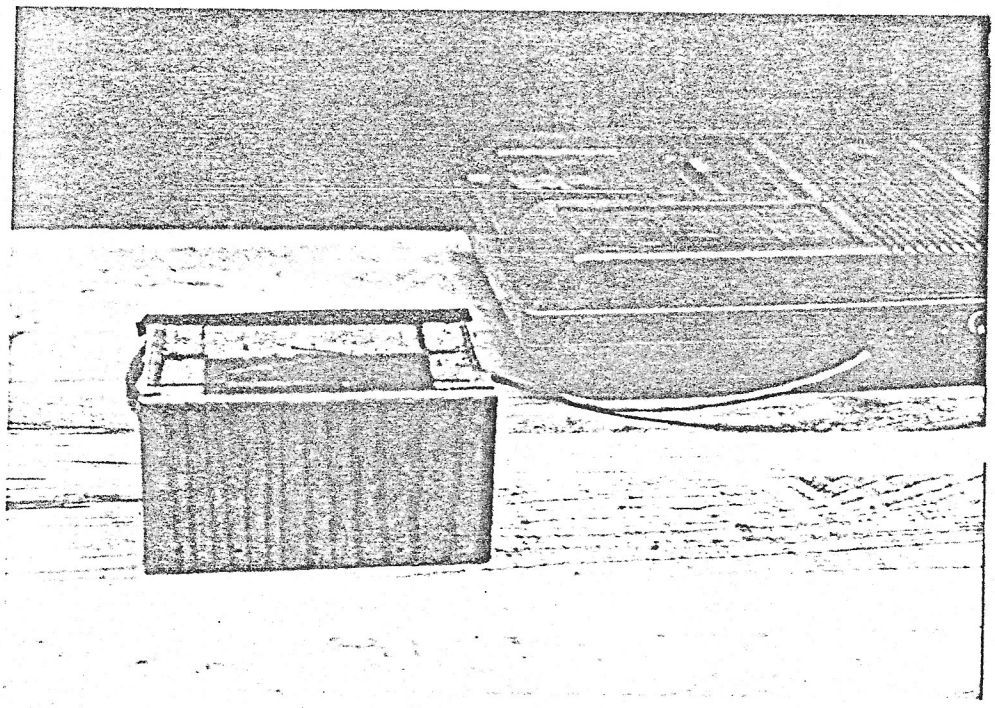


Figure 11. Photograph of the Touch Switch.



(a)

(b)

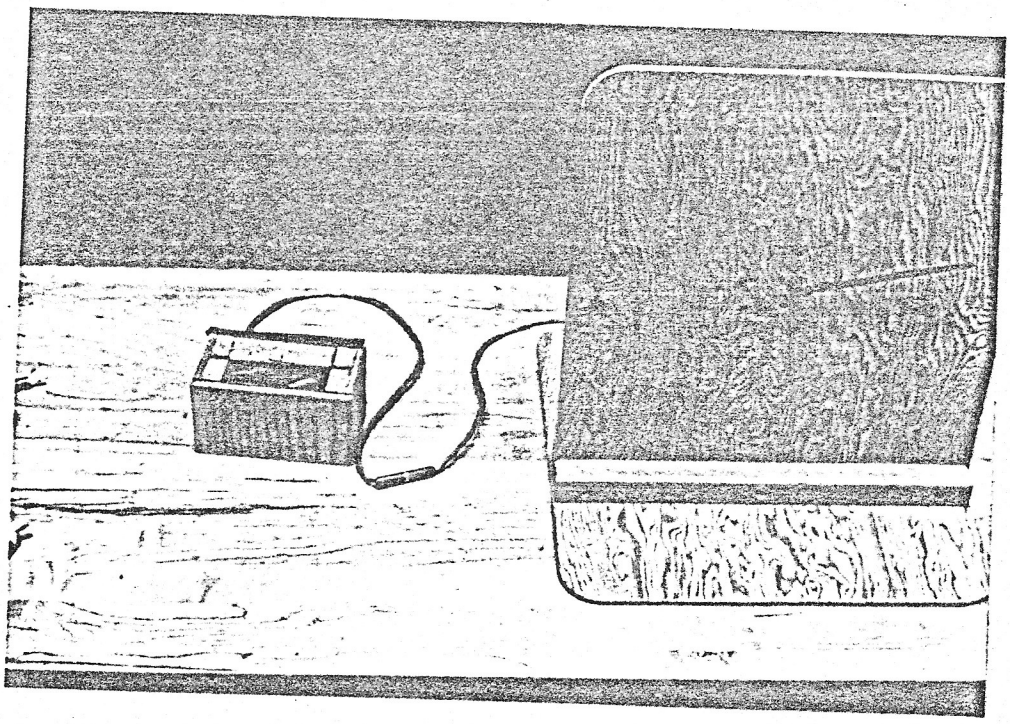
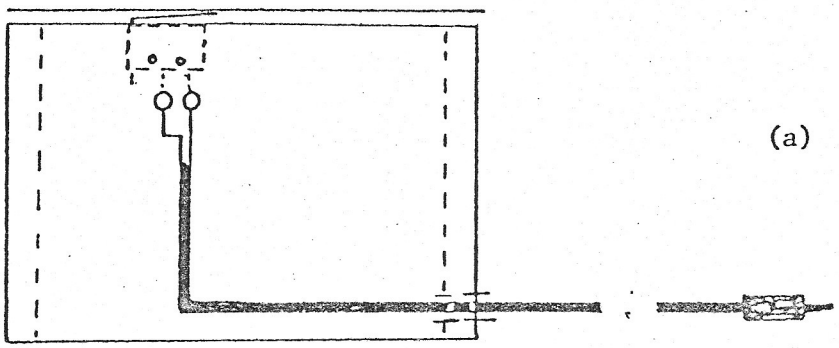
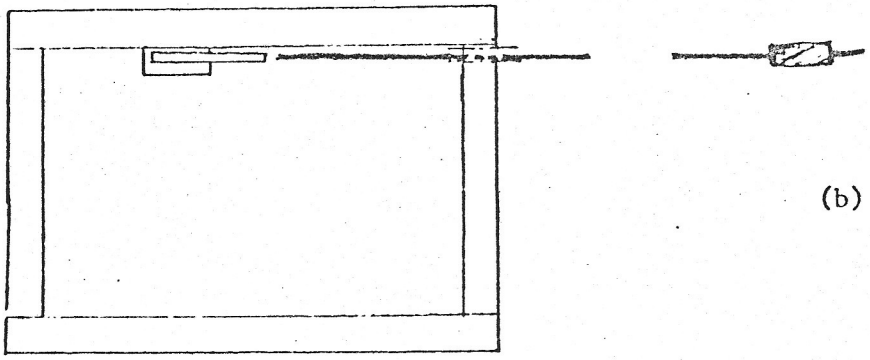


Figure 12. Photograph of the Touch Switch in combination with the Library of Congress tape player (a) and the Rotary Dial Communication Device (b) (to be discussed later).



(a)



(b)

- plug

o - connection point

Diagram 13. Diagram of the touch switch seen from the front (a) and top (b) views.

SQUEEZE SWITCH

Device name: Squeeze Switch

Rationale: This switch was developed to provide an input interface to reinforce developmentally delayed students for a grasping response useful in feeding skill development. Figures 14 and 15 present a photograph and a diagram of the squeeze switch respectively. This interface was also used by the author to elicit directed responses from a student who intentionally did little more than alternately open and close his fists.

Operating principles: A microswitch was sewn into a tube of gauze, and then connected to an output device in a normally off manner. The interface was placed in the student's palm and he was prompted to squeeze it, his gripping action depressing the lever of the microswitch and thereby activating the output device. The squeeze response required for operation of the output device was gradually changed to a pointing response by successively altering the position and operation of the microswitch. The materials needed for construction of this interface are listed in Appendix D.

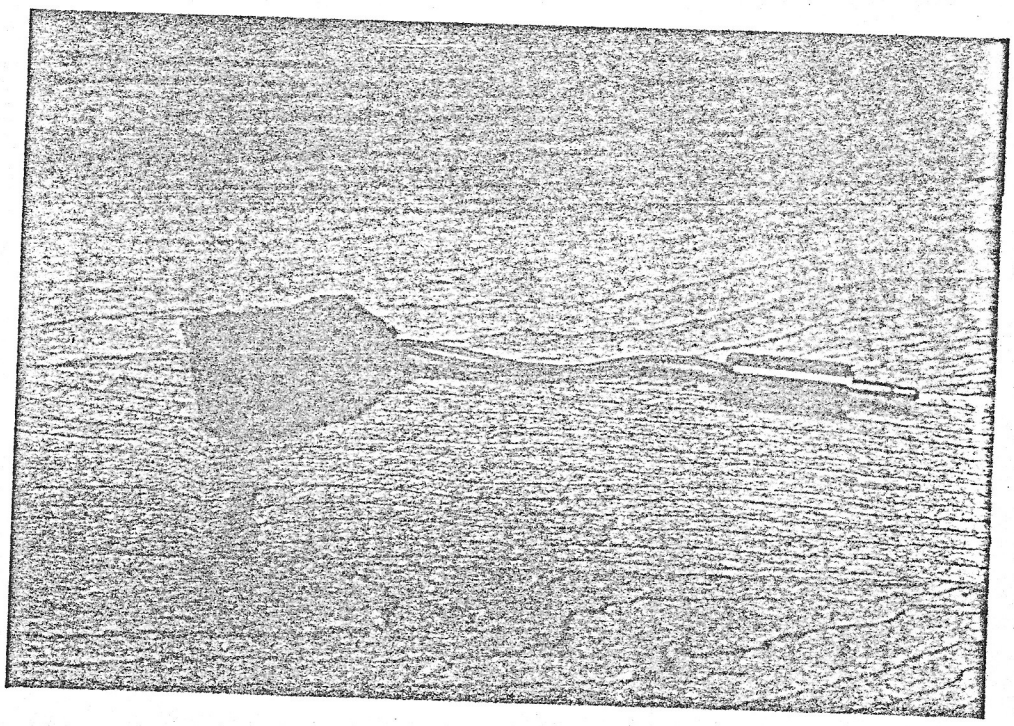


Figure 14. Photograph of the Squeeze Switch.

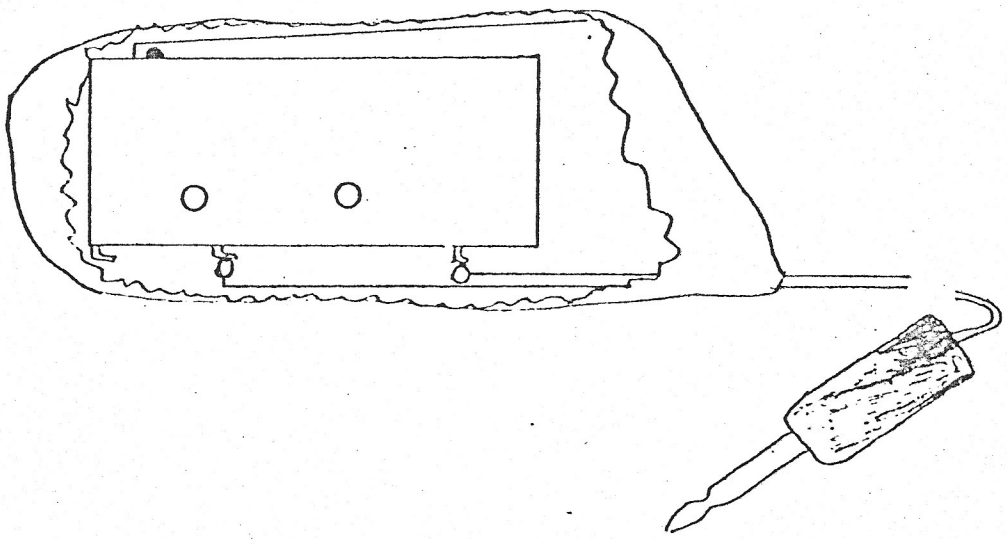


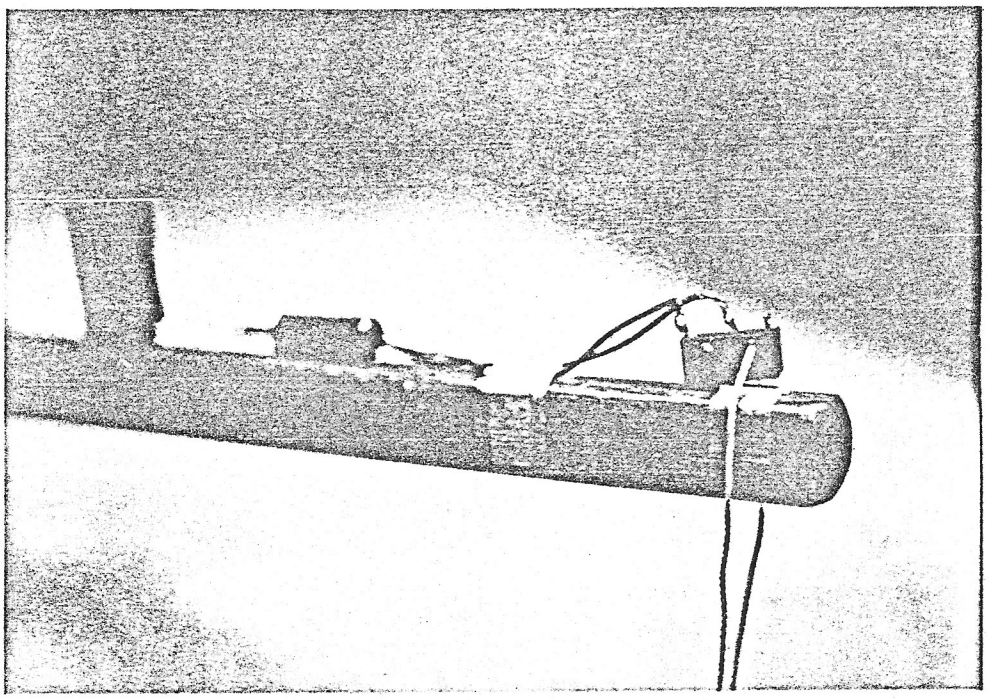
Figure 15. Diagram of the squeeze switch.

PULL SWITCH

Device name: Pull Switch

Rationale: This interface permits the development of eye-hand coordination, gross motor development, reach, grip and pull schemes, encourages the student to interact with his environment, and enhances the development of means-ends and cause-effect relationships.

Operating principles: By pulling the ring or any other attached object, the microswitch is activated as is shown by the photographs and diagrams presented in Figures 16 and 17. The microswitch, as in the above interfaces, activates the output device of choice. This unit can be mounted at the side of a crib, above a crib, or in front of a positioning wedge to encourage interaction with the environment, encourage position maintenance, and to provide stimulation from the environment. A materials list for construction of this interface is contained in Appendix D.



(a)

(b)

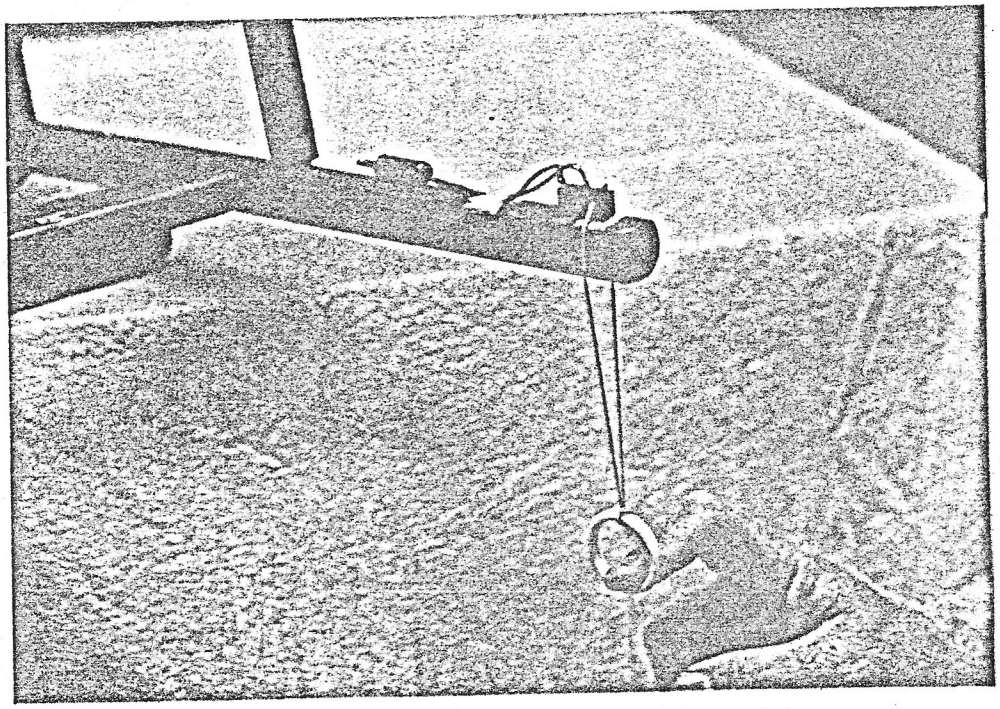
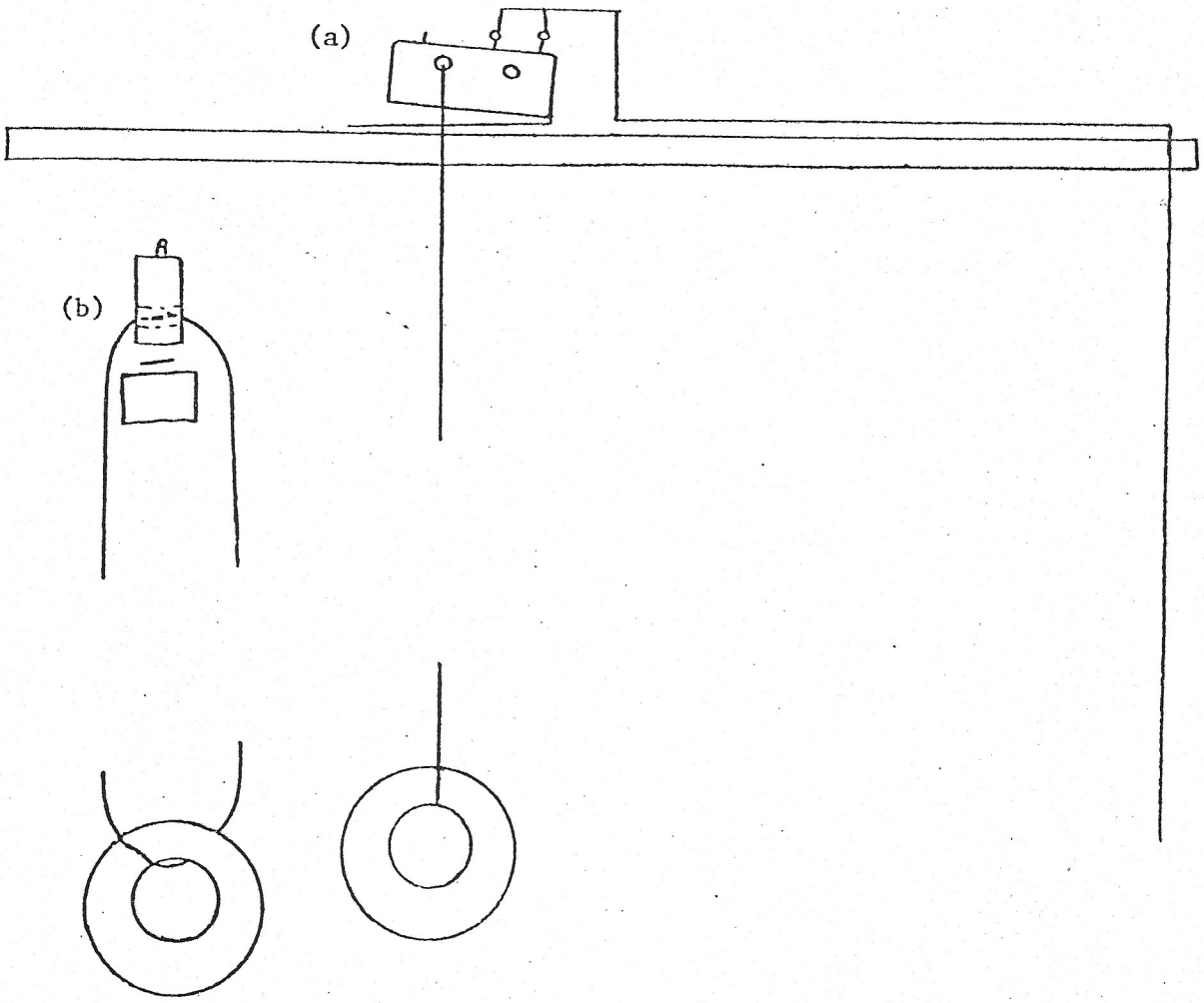


Figure 16. Photographs of the Pull Switch in the "off" position (a) and in the "on" position (b).



O - contact point

- hole

Figure 17. Diagrams of the pull switch from a side view (a) and from an end view (b).

HEAD POSITION TRAINER

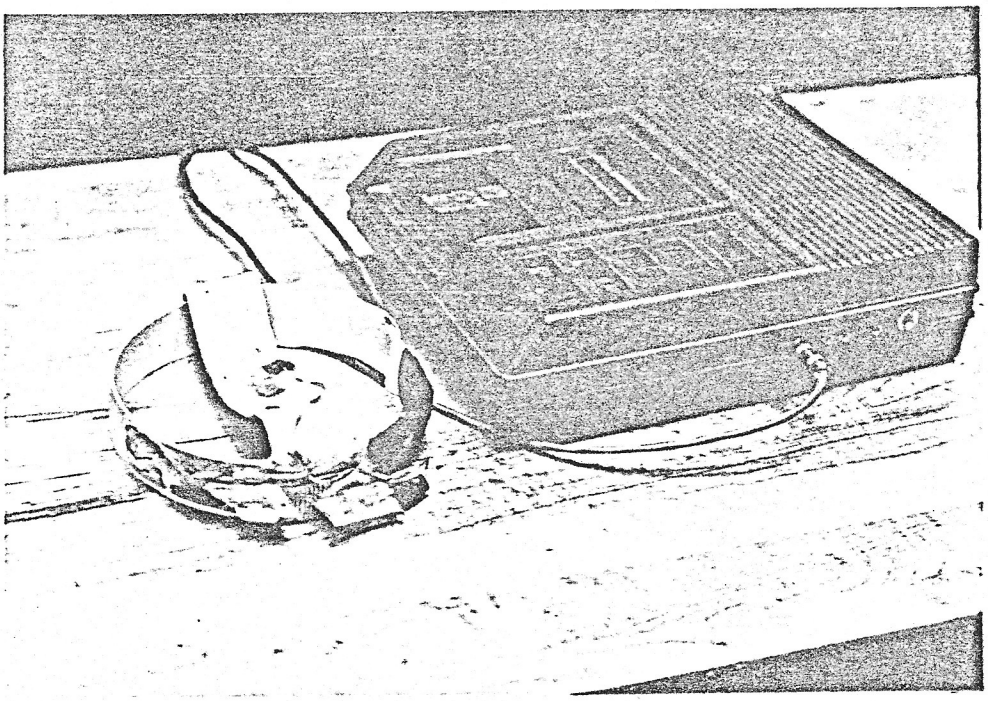
Device name: Head Position Trainer (HPT)

Rationale: This device was designed to increase the frequency and duration of an existing, but limited, head in midline behavior. The developmentally disabled student for whom this device was designed did not hold his head in a midline position often and when he did, it was only for short periods of time. The midline head position was seen as an important prerequisite to the development of communication skills. It was the consensus of the trainer and the consulting physical therapist that if the student had better head in midline behavior, he would see more of his environment. The student would have greater exposure to experience with and knowledge of his environment, providing him with information on how things operate (means-ends, cause-effect relations), providing him with topics for communication, and allowing him to have visual contact with things which he might desire and resultantly request.

Sources of information: Subsequent to the inception, design, construction and use of this device, several similar systems were discovered in the literature. The operating principles and functions performed by these devices were essentially the same, however the levels of sophistication regarding construction and use were quite diverse. The ranged from a single mercury switch mounted on the top of a hat (Ross,1976, p.5) to a system which automatically collects and records data for later retrieval (Mancino, 1977). The factor which might entice the classroom teacher to build a simple device specific to the student's needs, as Ross (1976) and this author suggest, rather than purchase one is ostensibly the cost involved. For instance, the device described by Mancino costs $400.00 (Mancino, 1977), and the one discussed by Ross (1976) is $5.00.

Operating principles: This device is essentially a large position sensitive "off/on" switch, see Figure 18(a). Three mercury switches connected in series complete the circuit when the child's head is in the desired position. Once the circuit is complete the tape player begins to play, thereby reinforcing the correct head position, see Figures 18(a), 18(b) and 19. Even if the tapes chosen are not reinforcing to the child, the novelty of the ability to control the tape player by head position could easily act as a reinforcing event. The placement of the mercury switches allows for criteria positions to be set for movement to the left, right, front and back, deviating from the desired midline position. This was accomplished by positioning each switch so that when the child moved from the desired position, the liquid metal, mercury, was drawn by gravity away from the two contacts sealed within the glass tube. This movement of the mercury breaks the connection and resultantly stops the tape player from operating. The angle at which the mercury switches are mounted on the head band determines the strictness of the criteria for "midline head position". This angle is entirely adjustable in that the switches are mounted with velcro strips. The child can therefore start with very lax position criteria for reinforcement, and through a fading process end up with a small area of correct position for reinforcement. This flexibility in positioning is very useful for both fading the criteria for reinforcement as well as allowing the device to be used for several students during the same class period.

This device provides immediate feedback/reinforcement to the student upon correct performance of the target behavior. It is not a substitute for instructor attention, but rather increases instructor attention and



(a)

(b)

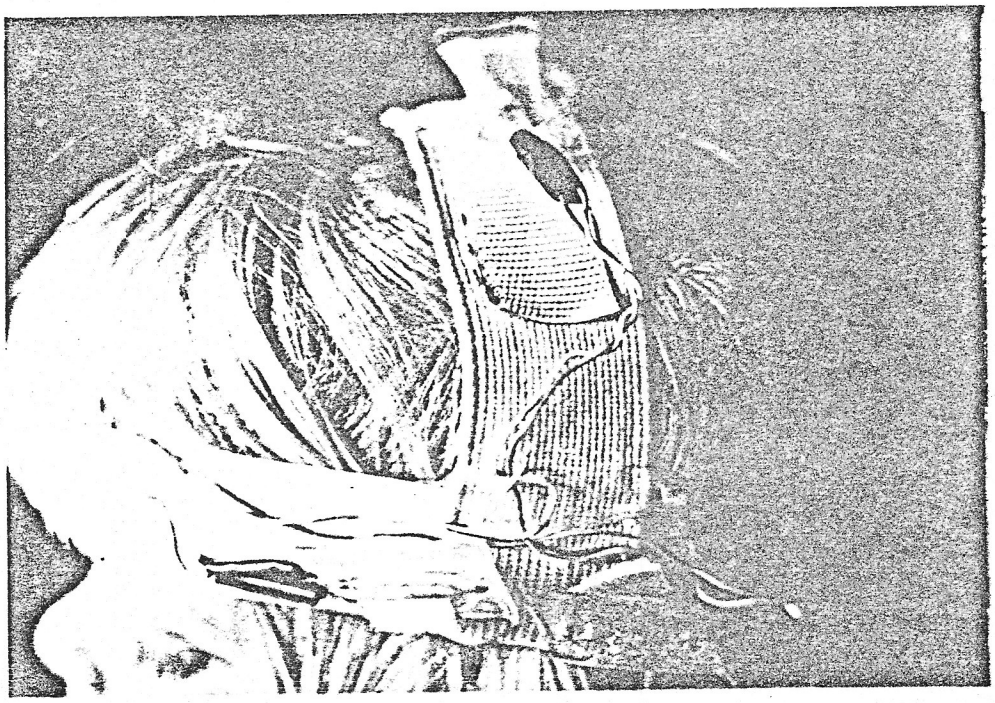


Figure 18. Photographs of the Head Position Trainer attached to the Library of Congress tape player (a) and positioned on a student's head (b).

(a)

(b)

Figure 19. Photographs of the Head Position Trainer in use with a student.

instructional time without increasing the direct time committment to the individual student. With such a device the teacher can work with another child while monitoring, visually and auditorily, the progress of the head position trainee's progress. The auditory monitoring allows the teacher to ascertain that the device and the child are both in proper positions when the device turns the tape player "on". The auditory monitoring allows the teacher to take both frequency and duration data based on the output of the tape player. The instructor should note that when recording the tapes for playback upon correct head position, the sounds should be fairly continuous, that is, without pauses or gaps. By doing this the child can consistently receive reinforcement for performing the target behavior, rather than receiving only the "whurr" of a blank tape for his efforts. It should also be noted that a physical therapist or occupational therapist should be consulted for an appropriate position to be trained so that a pathological or non-adaptive response is not trained.

It should be noted here that the three mercury switches are connected in series so that if the child moves from any of the desired parameters, the tape player will stop. The child must, therefore, simultaneously maintain all four parameters of head position to receive the reinforcement. The mercury switch mounted at the student's temple was used to control for both forward and left of midline movement, this was possible through positioning of the mercury switch at an angle away from his head. See Figure 20(a). Figure 20 (b) presents an alternate arrangement of the mercury switches which allows for two separate switches for the coronal position to control for left and right movements respectively. Figure 20 (c) illustrates a possible two switch system, each switch having control

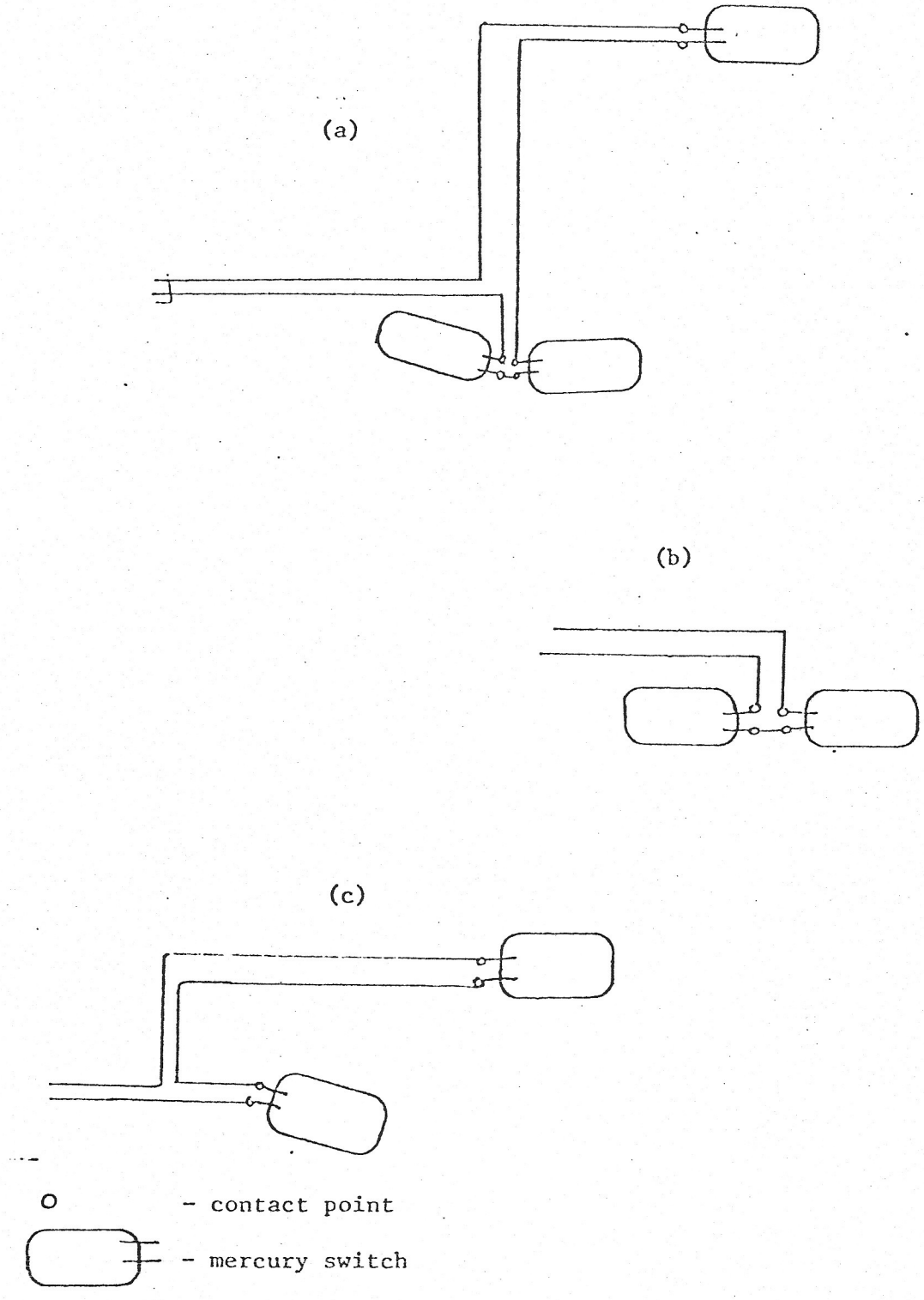


Figure 20. Diagram of the arrangement of the mercury switches of the head position trainer (a). Altered arrangement of the left-right controls for top mounting (b), or incorporation into the current coronal/temporal arrangement (c).

over one lateral movement and one anterior-posterior movement parameter. Appendix D presents the materials required for constructing this interface.

OUTPUT DEVICES

CONTINGENT

MUSIC

Device name; Contingent Music

Rationale: This auditory output mode was selected because it is easily obtained, it has inherent reinforcing qualities, potential as an auditory training tool, in addition to placing more of the student's environment under his control. This system was presented in the pictures in Figures 12(a) and 18(a).

Operating principles: This interface was plugged into the "remote on" jack of the Library of Congress tape player. When the tape player was set in the "on" position with the normal "off/on" switch, the interface of choice was in control of the "off/on" function of the tape player. As is true of all of the following output devices, the contingent music output was operable by all of the previously described input interfaces.

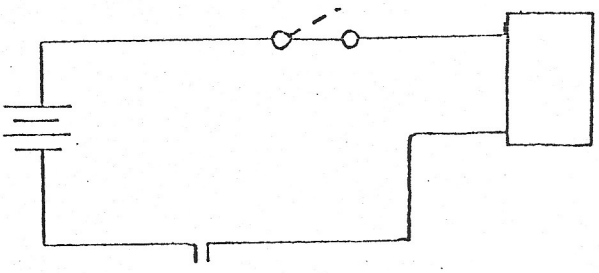
CONTINGENT

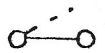
TOY OPERATION

Device name: Contingent Toy Operation

Rationale: This output device was developed to provide the student with a variety of stimuli which is operable contingent upon his responses. That is he would be given visual and auditory stimulation by an action / sound toy such as a train, musical bear, or other electrically powered toy.

Operating principles: The interface of choice becomes the "off/on" switch for the toy selected for operation. This "interfacing" may be done in several ways, dependent upon the type of power supply required by the toy. If the toy has a D.C. (direct current / battery)power source the circuit may be completed by an interface which is jacked into the circuit as is shown in Figure 21. Figure 22(a) illustrates a D.C. circuit which is broken by placing a nonconductor (mica washer) between the batteries and their contact as could be done with a flashlight between the batteries and the wire coil at the base. This nonconductor stops the electricity from passing by, however if an interface is attached to the contact points of the circuit, the "off/on" function will again be transfered to the interface. Figure 22(b) depicts the same end result, although in it the interface was merely connected in series with the normal switch. Of these three strategies only the one presented in Figure 22(b) permits the toy to be operated through both the normal and the interfaced "off/on" switches. The materials required for the construction of these three interfacing schemes are presented in Appendix D.





- switch in "on" position

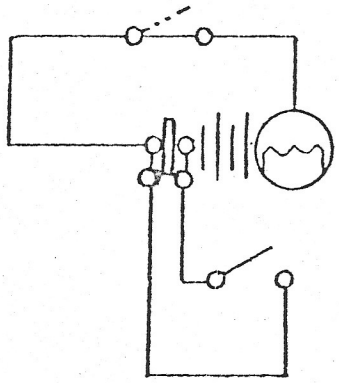
- power source

- toy

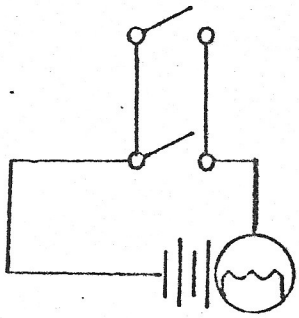
- plug to interface

Figure 21. Diagram of the circuitry for contingent toy operation.

(a)



(b)



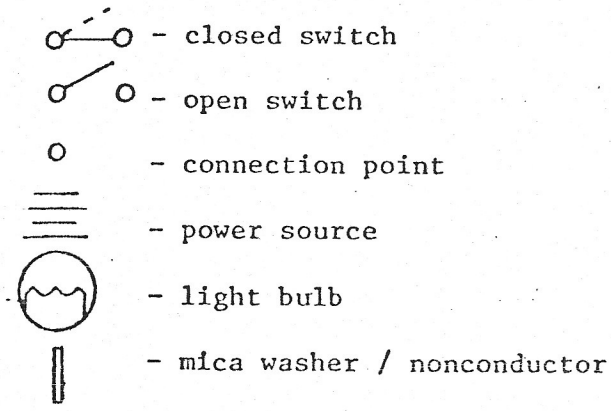


Figure 22. Diagram for "off/on" control of a device with a D.C. power source. A nonconductor may be placed in the circuit (a) or the interface may be connected in parallel with the normal "off/on" switch.

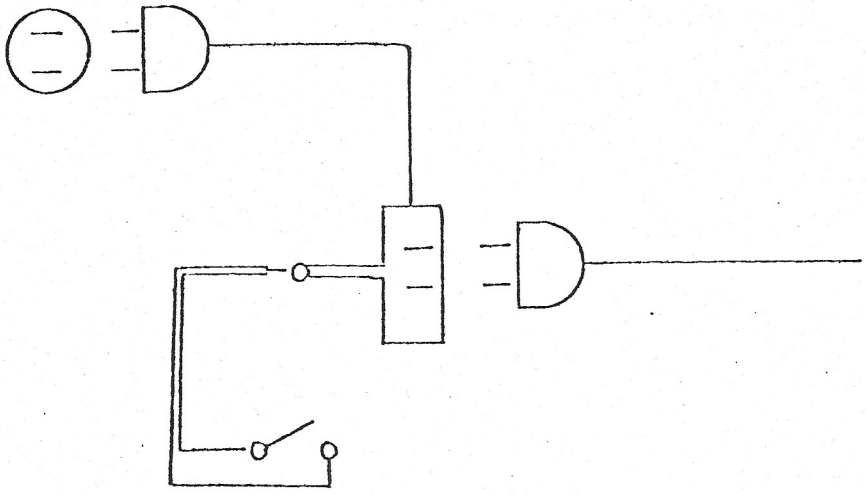
CONTINGENT

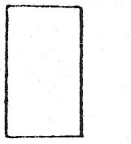
LIGHT

Device name; Contingent Light

Rationale: These output forms were developed to provide a variety of response contingent visual stimuli.

Operating principles: Upon correct activation of the selected interface, the light source is provided with the electricity required for operation. The output forms suggested here are a flashlight (Figures 21, 22(a) and 22 [b]), flashing Christmas tree lights, and a rotating color wheel used to illuminate a Christmas tree (Figure 23).





- intermediate switching system

- power outlet

- power plug

- interface

- jack
- plug

Figure 23. Diagram for "off/on" control of a device with an A.C. power source via an intermediate switching system.

CONTINGENT

VIBRATION / FAN OPERATION

Device name: Contingent Vibration / Contingent Fan Operation

Rationale: These output forms were developed to provide tactile stimulation as a form of reinforcement for those students with limited vision and/or hearing, those who do not respond well for visual or auditory reinforcement, or those who are very responsive to tactile stimulation.

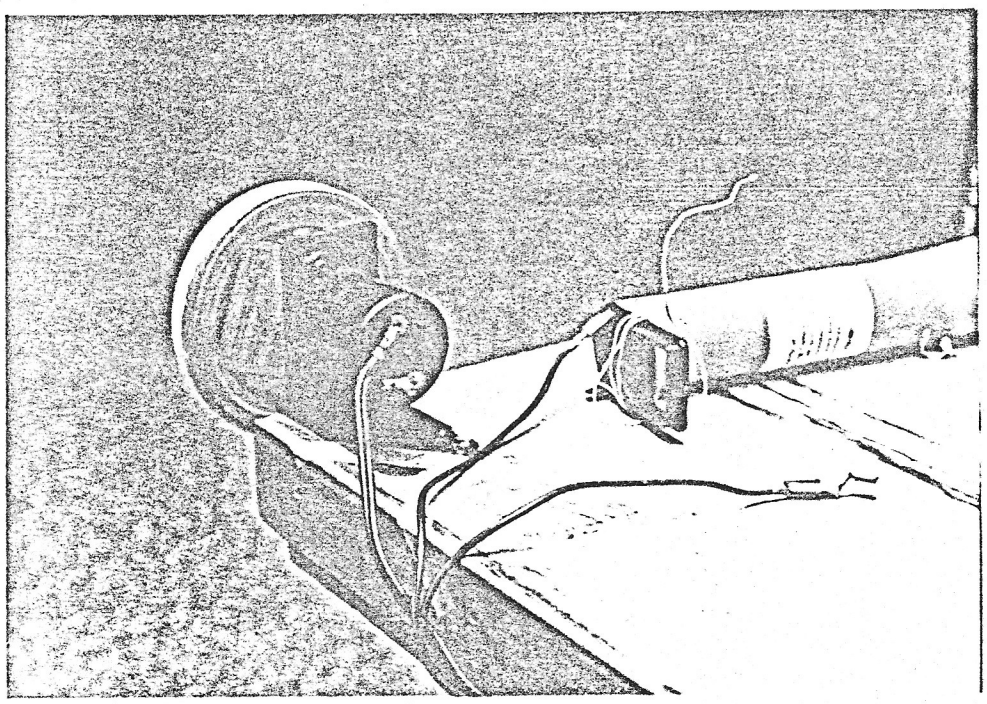
Operating principles: Successful operation of the individually selected interface activates a fan placed near the student or a vibrator attached to the student's bed or chair. The diagrams presented in Figures 21,22, and 23 are also applicable to these output devices dependent upon the nature of their particular type of power supply.

MOBILE / KALEIDOSCOPE

Device name: Mobile / Kaleidoscope

Rationale: This output device was developed to provide a visual form of reinforcement which incorporated movement, color, and yet had enough variation that the student would not tire of it quickly.

Operating principles: A disk was mounted on the axis of a low RPM (revolution per minute) motor. When the student operated the interface, the axis would turn the disk. For the mobile, this unit was suspended above or beside the student's bed and a variety of objects were suspended from the disk. In the kaleidoscope mode the disk had several small, brightly colored objects placed within it, and the clear plastic disk was placed in a vertical plane in front of the student. Photographs of the basic mechanism for the mobile, kaleidoscope, and rotary dial communication device (discussed below) are presented in Figure 24. A photograph of the output surface of the kaleidoscope is presented in Figure 25. The circuit diagram is presented in diagram 26. It should be noted that the motors and batteries used for the mobile, kaleidoscope and rotary dial communication device seen in Figures 24, 25, and 26 were donated by a bakery, which had used them for an animated store display.



(a)

(b)

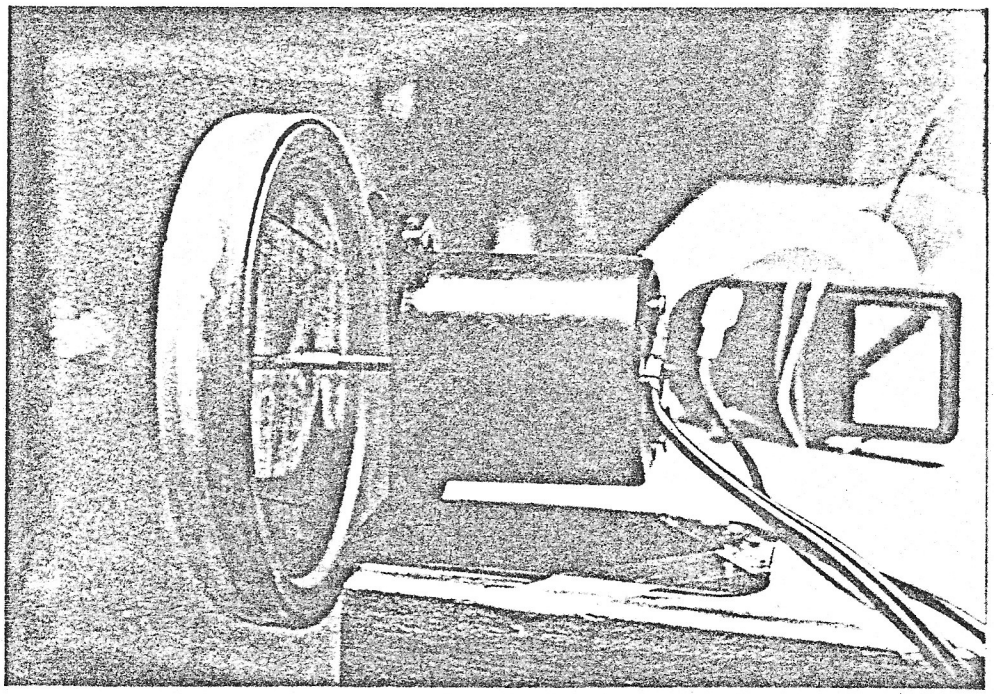
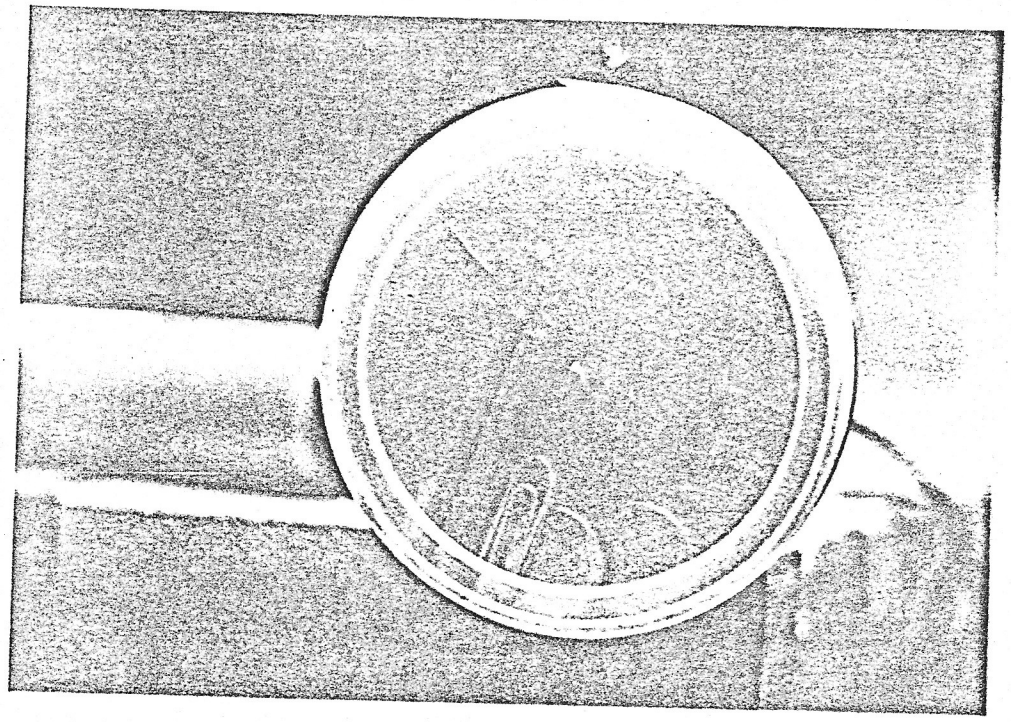


Figure 24. Photographs of the basic mechanism used for the Kaleidoscope, Mobile, and Rotary Dial Communication Device.



(a)

(b)

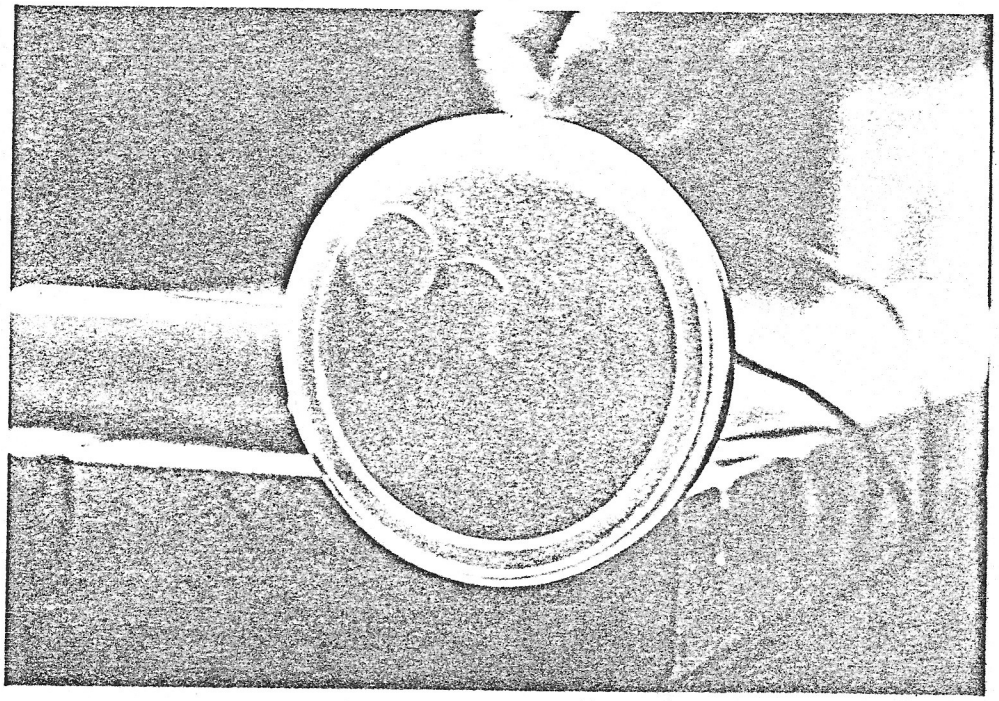
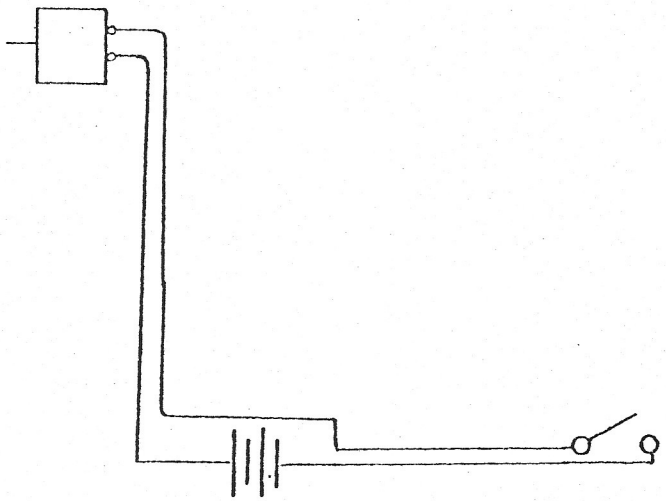
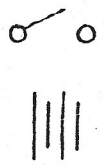


Figure 25. Photograph of an output surface for the Kaleidoscope.

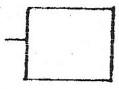




- interface

- power supply

- contact point



- motor

Figure 26. Diagram of the basic motor / battery unit used in the mobile, kaleidoscope, and rotary dial communication device.

ROTARY DIAL

COMMUNICATION

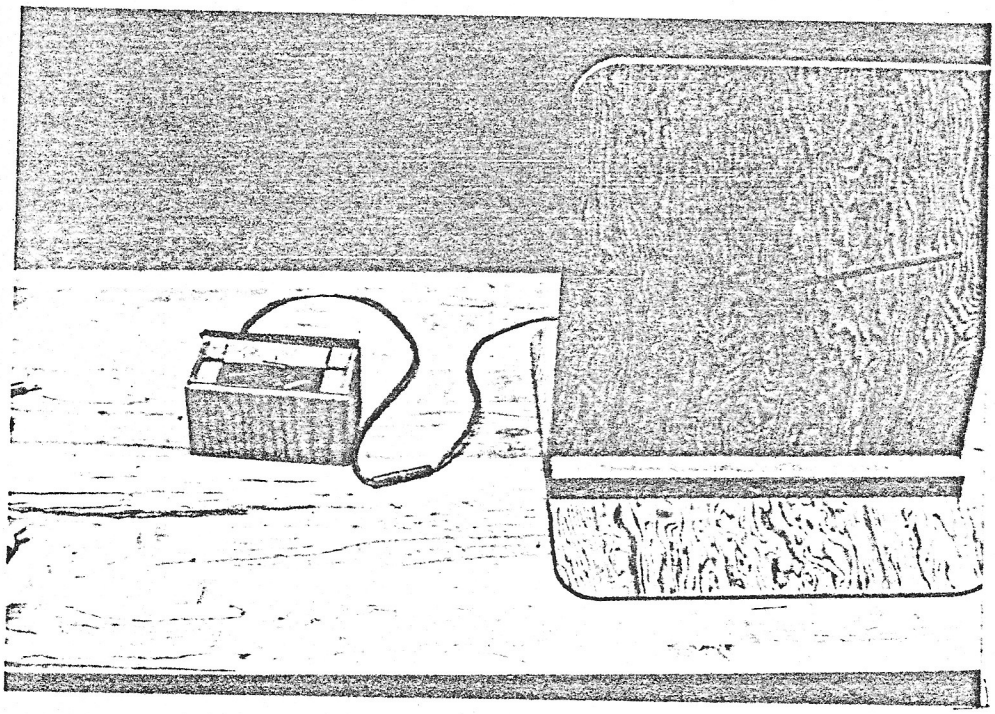
DEVICE

Device name: Rotary Dial Communication Device

Rationale: This device provides a scanning procedure and a communication board surface for the student who has a range of motion too limited to benefit from the use of a conventional communication board.

Sources of information: Devices such as this have been discussed by Lavoy (1957), Jones (1961), and Mancino (1977) as an alternative means for communication with and assessment of nonverbal students having a limited range of motion.

Operating principles: The student applies pressure to the touch switch (or any other activation scheme to any selected interface) which starts the movement of a low RPM (revolution per minute) motor. See Figure 26 and 27. As the axis of the motor rotates, it moves a pointer (seen in the center of the wooden surface, in the right of Figure 27(a)) around the front of the clock-like surface of the device. Around the circumference of the pointer's course are placed symbols, pictures, objects, or words for the student's communicative needs, training, and skill testing tasks. By operating the interface, the student can scan through a variety of messages until he indicates the one which he intends to communicate. The student stops the movement of the pointer by releasing the interface from his contact. Beyond use for testing and communication, this device provides a vehicle for increasing the student's range of motion for later use of a conventional communication board. The material list for this device is presented in Appendix D.



(a)

(b)

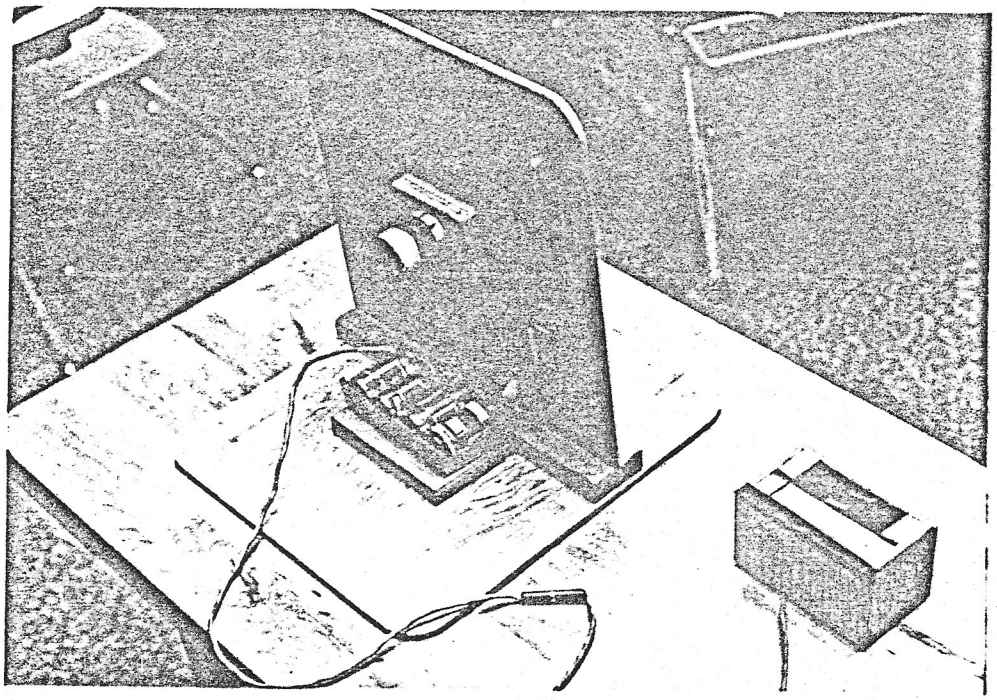


Figure 27. Photographs of the Rotary Dial Communication Device from a front (a) and side view (b).

NON-ELECTRIC

COMMUNICATION BOARD

AN INPUT/OUTPUT

DEVICE

COMMUNICATION BOARD/TRAINER

Device name: Communication Board / Trainer

Rationale: This unit was devised because of the necessity for altering the items on the communication board during training and initial usage. An additional motivation was the general nature of the target population.

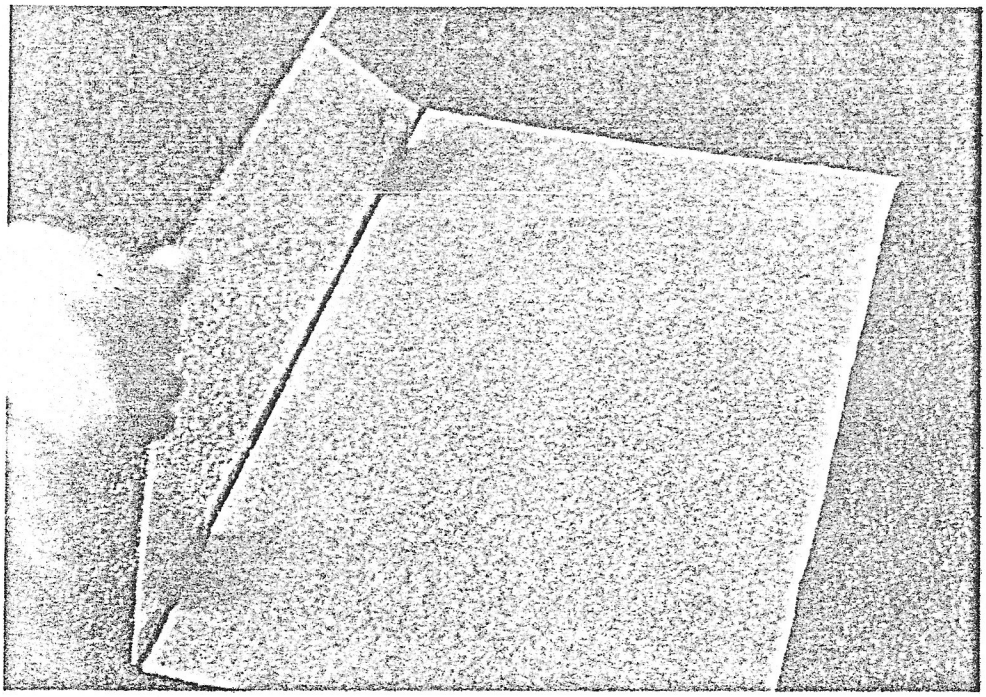
Operating principles: A hinged plexiglass shield protects the symbols and other flat materials from damage due to moisture or student manipulation. See Figures 28, 29 and 30. The plexiglass shield also permits the instructor to alter the contents of the board to introduce new words and keep the vocabulary compatable with the student's needs, assess his ability, and present varied training stimuli to facilitate generalization. The plexiglass was hinged to a piece of 1/4" hardboard by two pieces of flexible rubber. These rubber hinges acted to elevate the top surface of the board and thereby reduce the glare of the room lights, as well as producing some friction to keep the board from sliding on the table when used. The materials needed for construction of this unit are contained in Appendix D.

The above input interfaces and output devices can be combined specific to the student's physical and programmatic needs, and used to motivate the student's indepenent play, discovery, experience or performance in training settings. These classroom materials may be used in data based programs or as related experiences for building generalization of the target behavior. Teachers might even use the technology presented in this paper to construct classroom and home environments which are adaptable to control by the student with any of a variety of disabilities.

Regardless of the extent to which the above technology, ideas, and information are used, it is the role of the classroom teacher to initiate the process, request the assistance, and coordinate the professionals involved in the actual construction of the device(s). The classroom teacher is the one who must locate, procure or develop the educational materials specific to the needs of the individual student.

The instructor may need to locate an interested and helpful electrical engineer, shop teacher, electronics class, or school maintenance person to actually construct the device. The services of an occupational therapist or physical therapist will most probably be required to determine the appropriate / nonpathologic nature of the skill to being taught. The classroom teacher is the person who knows the skills needed by the student, and therefore is the one who must coordinate the efforts of the therapist in determining the most "normal" motor patterns to be used with the efforts of the person who is constructing the device. In this coordinated manner the student will receive the most appropriately "fitted" input/output system.

As can easily be seen from the variety of teacher made educational materials presented above, the primary limitations to the development and use of such technology are the creativity and motivation of the instructor.



(a)

(b)

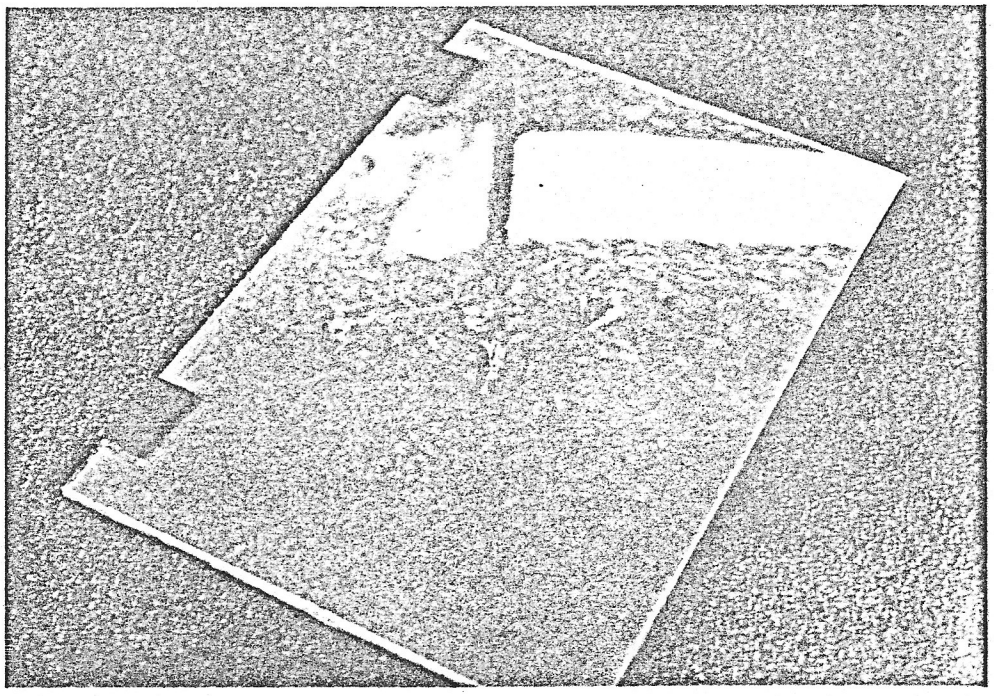


Figure 28. Photographs of the Communication Board / Trainer with the plexiglass shield open (a) and down (b).

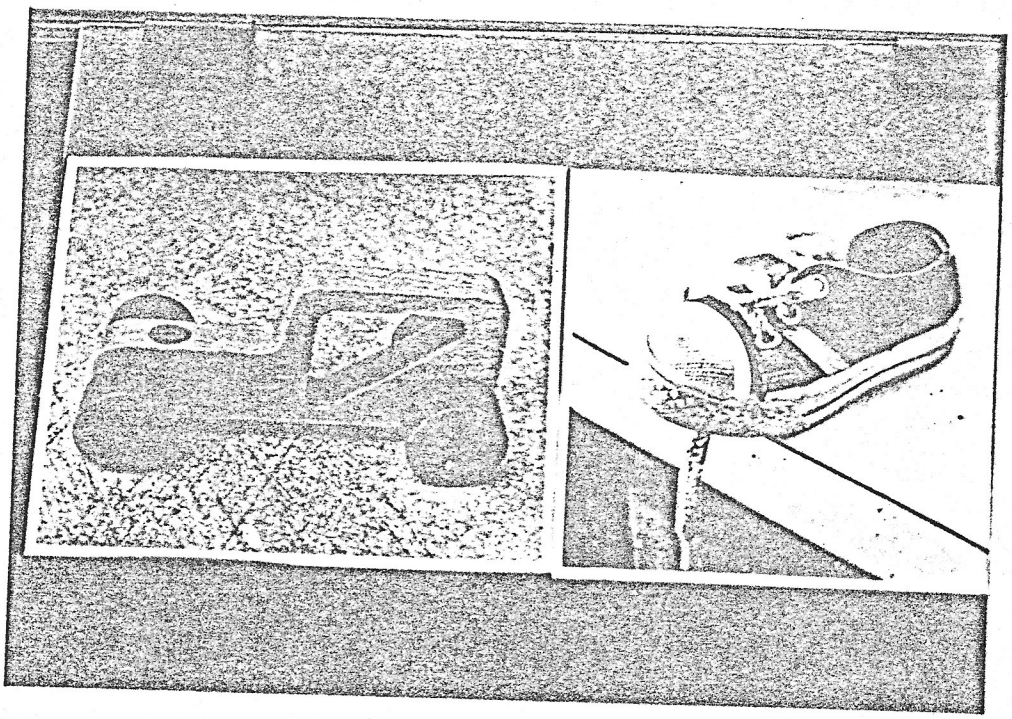
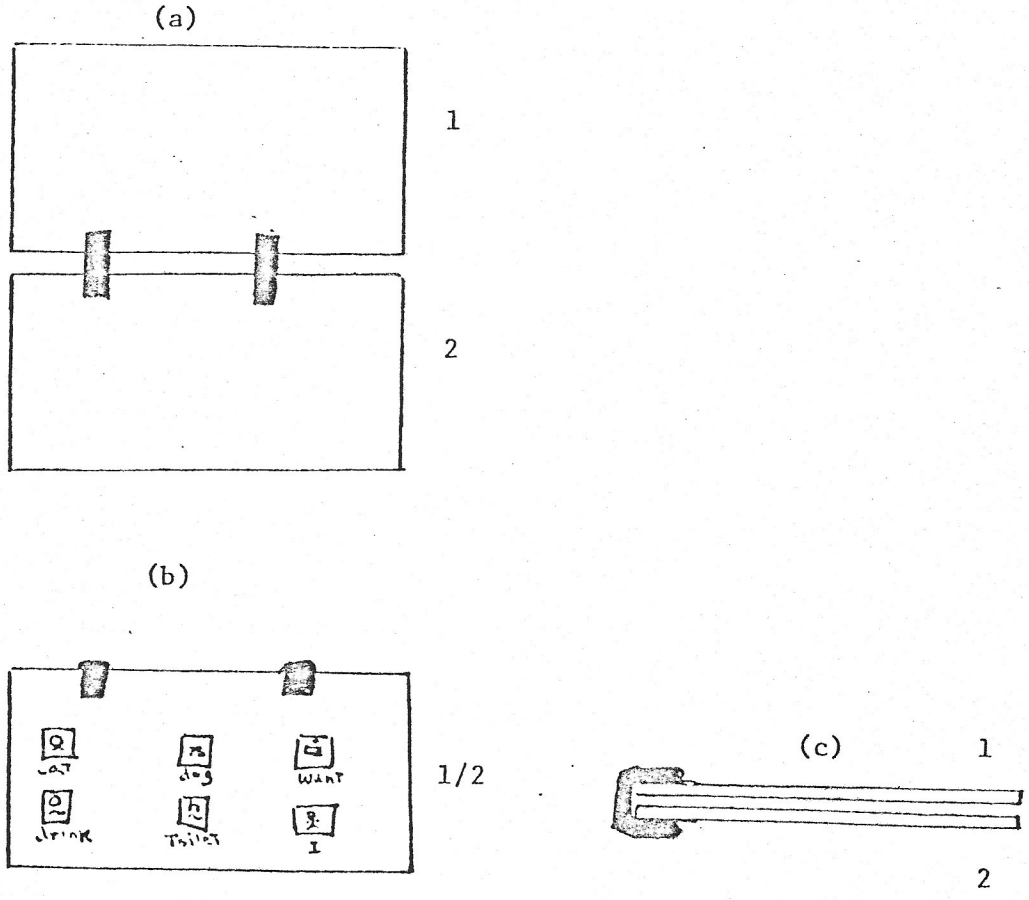


Figure 29. Photograph of the Communication Board / Trainer with two pictures in position for training.



1 - plexiglass shield

2 - hardboard

▩ - rubber hinges

Figure 30. Presents three views of the Communication Board / Trainer. (a) Completely opened as seen form the back side to illustrate the placement of the rubber hinges, (b) closed and seen from the top view, the plexiglass -1- covers the symbol display and the hardboard -2-, and (c) an enlarged end view illustrating the hinge attachment.

The above input interfaces and output devices can be combined specific to the student's physical and programmatic needs, and used to motivate the student's indepenent play, discovery, experience or performance in training settings. These classroom materials may be used in data based programs or as related experiences for building generalization of the target behavior. Teachers might even use the technology presented in this paper to construct classroom and home environments which are adaptable to control by the student with any of a variety of disabilities.

Regardless of the extent to which the above technology, ideas, and information are used, it is the role of the classroom teacher to initiate the process, request the assistance, and coordinate the professionals involved in the actual construction of the device(s). The classroom teacher is the one who must locate, procure or develop the educational materials specific to the needs of the individual student.

The instructor may need to locate an interested and helpful electrical engineer, shop teacher, electronics class, or school maintenance person to actually construct the device. The services of an occupational therapist or physical therapist will most probably be required to determine the appropriate / nonpathologic nature of the skill to being taught. The classroom teacher is the person who knows the skills needed by the student, and therefore is the one who must coordinate the efforts of the therapist in determining the most "normal" motor patterns to be used with the efforts of the person who is constructing the device. In this coordinated manner the student will receive the most appropriately "fitted" input/output system.

As can easily be seen from the variety of teacher made educational materials presented above, the primary limitations to the development and use of such technology are the creativity and motivation of the instructor.

APPENDIX A

APPENDIX A

HOW TO CONTACT THE LIBRARY OF CONGRESS AND TELEPHONE PIONEERS

Library of Congress - Division of Blind and Handicapped Services

The Division of Blind and Handicapped Services may be located through your state or local library or through the use of the national telephone directory located at the back of this appendix.

Telephone Pioneers

1. Call the operator and ask for the phone number of the branch manager of the local office of the telephone company.
2. Request either the operator or the branch manager of the phone company to give you the name and number of either the secretary or chairperson of the local telephone pioneers chapter. They will generally take your name and number and have the requested person call you.
3. Describe your program needs to the chairperson or secretary, and he/she will assign some members of the "Pioneers" to your project. If you are seeking either the Audio Ball or the VOX Relay, the acquisition process will be speed up by providing them with the following information for locating the chapters responsible for construction and distribution of these devices.

APPENDIX A

HOW TO CONTACT THE

LIBRARY OF CONGRESS

AND

TELEPHONE PIONEERS

Audio Ball

Rita Sweeney / Audio Ball
C/O Merrimack Valley Workers Chapter #78
Telephone Pioneers of America
1600 Osgood Street
North Andover, Massachusetts 01845 1 (617) 681-2310

VOX Relay

Bob Wade
C/O Illinois Bell Telephone Co.
Telephone Pioneers of America
406 E. Monroe
3erd Floor West
Springfield, Illinois 62725 1 (217) 789-5438

An additional source of materials from which the Telephone Pioneers may draw in meeting your program needs is the Light House for the Blind. [Florida 856-2288]

The New York Center for the American Foundation for the Blind is also a good source of materials and information. [New York 1 (212) 924-0420]

The person in charge for your project will then locate and purchase your materials, and then donate them to your center or to the child which you have indicated. It should be noted that the "Pioneers" have neither the educational background nor the experience with the handicapped which is required in selecting the stuffed "toy" in which the VOX relay is to be placed. The instructor must therefore provide considerations for selection or select one for the student and give it to the "pioneer" responsible for your project. The criteria of reference being: small size, washable exterior, minimal distractions in the color (ie a brown bear rather than a zebra or tiger).

APPENDIX B

APPENDIX B

GENERAL SOURCES OF MATERIALS

SUPPLY HOUSES

Bill Godbout Electronics
Box 2355
Oakland Airport, California
94614 (415) 562-0636

Delta Electronics
P.O. Box 1
Lynn, Massachusetts
01903 (617) 380-4705

Digi-Key
Box 667
Thief River Falls, Minnesota
56701 (218) 681-6674

Edmund Scientific Co.
150 Edscorp Bldg.
Barrington, New Jersey
08007 (609) 547-3488

Electronics Distributors, Inc.
4900 W. Elston
Chicago, Illinois
60630 283-4800

James Electronics
1021 Howard Avenue
San Carlos, California
94070 (415) 592-8097

Lafayette Radio Electronics
111 Jericho Turnpike
Syosset, New York
11791

Meshna
P.O. Box 62
E. Lynn, Massachusetts
01904

Olson Electronics
260 South Forge Street
Akron, Ohio
44327

APPENDIX B

GENERAL SOURCES OF MATERIALS

SUPPLY HOUSES
(continued)

Poly-Packs
P.O. Box 942
South Lynnfield, Massachusetts
10940 (617) 245-3829

Radio Shack
2617 West 7th Street
Fort Worth, Texas
76107

W.W. Grainger, Inc.
2616 - 27th. Avenue South
Minneapolis, Minnesota (612) 721-5531
55406

Note: Local distributors for the above companies may be found in your community.

APPENDIX C

APPENDIX C

SOURCES OF RELATED INFORMATION

PERIODICALS

AAESPH
P.O. Box 15287
Seattle, Washington
98115
(American Association for the Education of the Severely and Profoundly Handicapped)

ASET
Gordon Bleil
Edmark Associates
13241 Northrup Way
Bellevue, Washington
98005
(Association for Special Education Technology)

Behavioral Research Methods and Instrumentation
The Psychometric Society, Inc.
1108 West 34 Street
Austin, Texas
78705

Behavioral Engineering
P.O. Box 1473
Grand Island, Nebraska
68801

Byte - The Small Systems Journal
70 Main Street
Peterbourough, New Hampshire
03458

Journal of Applied Behavioral Analysis
Department of Human Development
University of Kansas
Lawrence, Kansas
66045

Popular Electronics
1 Park Avenue
New York, New York
10016

APPENDIX C

SOURCES OF RELATED INFORMATION

REFERENCES

Aids for the Severely Handicapped
Edited by Keith Copeland, 1974.

Computer Lib/Dream Machines
Ted Nelson

Electronic Projects for Musicians
Craig Anderson
Guitar Players Productions, 1976.

How to Read Schematic Diagrams
Donald E. Harrington, 1976.
Howard W. Sams ans Co. Inc.
Indianapolis, Indiana
46268

Introduction to Microcomputers
Adam Osborne

Scientific American
September issue (77), 1977.

The Family Handyman
Vol. 27, September 1977, p. 30-33

TTL Cookbook
Don Lancaster, 1974.
Howard W. Sams and Co. Inc.
Indianapolis, Indiana
46268

TTL Data Book
National Semiconductor Corporation, 1976.
2900 Semiconductor Drive
Santa Clara, California 1 (408) 737-5000
95051

APPENDIX C

SOURCES OF RELATED INFORMATION

COMMERCIAL EQUIPMENT

BRS/LVE
5301 Holland Drive
Beltsville, Maryland 20705
(write for the Human Test Catalogue)

Coulbourn Instrument, Inc.
Box 2551
Lehigh Valley, Pennsylvania 18100
1 (215) 395-3771

Handicapped Children's Technological Services
RFD #2
Box 60 B
Foster, Rhode Island 02825

Lafayette Instrument Company
P.O. Box 1279
Sagamore Parkway North
Lafayette, Indiana 47902
1 (317) 423-1505

Lafayette Instrument, Inc.
Attention: Mr. Ralph H. Moyer
Eastern Regional Office
2116 Allen Street
Allentown, Pennsylvania 18104

Prentke Romich Company
RD. #2 Box 191
Shreve, Ohio 44676
1 (216) 567-2906

Ralph Gerbrands Company
8 Becks Road
Arlington, Massachusetts 02174

Rayfield Equipment
5462 S. Cornell
Chicago, Illinois 60615
1 (312) 643-7421

APPENDIX C

SOURCES OF RELATED INFORMATION

COMERCIAL EQUIPMENT
(continued)

Stoelting Company
1350 South Kostner Avenue
Chicago, Illinois
60623

(Write for the Psych. Tests and Instruments Catalogue)

Testan Scientific Instruments
P.O. Box 267
Davis, California
95616

Wayne Engineering
4120 Greenwood Ave.
Skokie, Illinois
60076

1 (312) 676-2171

APPENDIX D

APPENDIX D

MATERIALS LIST

This paper was presented, not as a technical guide for construction, but as an idea book, containing principles of operation and application of a variety of teacher made educational materials. The materials list therefore does not contain any specifications for those items listed for any particular device. The dimensions are left to the instructor, as it he/she who best knows the student's physical needs and abilities. The only caution is that the instructor be certain that the components are compatable with one another, that is the plugs match the jacks in size, and that any circuitry containing complex interconnections should be checked by someone who knows about electricity before the student is placed in contact with it. A second note of caution is that the wires used in constructing of the materials should be of a multiple strand type, as it stands up to movement much longer than does the single strand type.

APPENDIX D

MATERIALS LIST

Touch Switch
(Figures 11, 12, and 13)

1. 1- microswitch
2. 1-plug and wire

1. 4 (or 5)-pieces of wood, plastic, or metal (for the box)
2. 1-piece of plexiglass (for lid to box /trigger plate for activation)

Squeeze Switch
(Figures 14 and 15)

1. 1-microswitch
2. 1-plug and wire

1. 1-piece of gauze material
2. 1-thread to sew the gauze around the microswitch

Pull Switch
(Figures 17 and 17)

1. 1-microswitch
2. 1-plug and wire

1. 1-string
2. 1-object for the student to grasp and pull

Head Position Trainer
(Figures 18, 19 and 20)

1. ( )-mercury switches (number determined by the arrangement selected from Figure 20 and discussion. generally between 2 and 4 mercury switches)
2. 1-plug and wire

1. 1-strip of material to go around the student's head (anterior-posterior)
2. 1-piece of elastic or other means of making the above strip adjustable
3. 1-piece of material to go across the top of the student's head (coronal)
4. 1-Velcro hook/loop strip for each mercury switch (to allow for adjustment of the position of the mercury switches).
5. some means of making the mercury switches "child safe" This can be done by ordering plastic or unbreakable mercury switches, with flexible wires attached at the end of the two metal poles. Look carefully at the pictures in the order catalogue, if you are fortunate enough to locate a good one. In that there a great number of varieties of mercury switches

APPENDIX D

MATERIALS LIST

Head Position Trainer
(Considerations on mercury switch selection)
continued

5. available due to their wide use in industry. Be certain that the mercury switch that you select will do the job that it is intended to do.

If you can not get "just the mercury switch that you want", that is if you find or are given some mercury switches you can make them "child safe". You will need ...

1. 1-heat shrink tubing (just the right size for the mercury switch, once it has shrunk onto the mercury switch it makes it shatter-proof, so that if it does break the glass and mercury will not harm the child)
2. 1-heat shrink tubing (whose shrunken dimensions are larger than those of the mercury switch, this material is placed around the mercury switch [already encased in the previous heat shrink tube])
3. 1-container of a gelatinous glue (This material is injected between the two layers of tubing as a protective "bumper" for the mercury switch)

Note: The tubing may be obtained as a donation from an electronics warehouse, the warehouse manager may even assign someone from the warehouse to shrink the tubing on the mercury switches. If they do not shrink the tubing, it may be done in your own oven at home.

Kaleidoscope
(Figures 24, 25, and 26)

1. 1-low RPM (revolution per minute), D.C. (direct current / battery), motor
2. 1-battery supply appropriate to the requirements of the motor
3. 1-jack (allows the input from any of the above interfaces)
4. () small, colorful objects of different shapes (to be placed in the disk for display)
5. 2-plastic lids (ie. coffee can lids)

place the objects in the lids, glue the lids together, and attach them to the axis of the motor.

APPENDIX D

MATERIALS LIST

Mobile
(Figures 24 and 26)

1. 1-low RPM, D.C. motor
2. 1- battery supply
3. 1-jack
4. 1-disk (to attach to the axis of the motor)
5. () objects to attach to the disk
6. () string to attach the objects to the disk (colorful yarn)

Rotary Dial Communication Device
(Figures 24, 26 and 27)

1. 1-low rpm, D.C. motor
2. 1-battery supply (ie 4 "D" cell batteries)
3. 2-"D" cell battery holder
4. 1-jack and wire (to the interface)

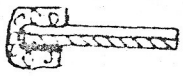
1. 1-display surface (Figure 27)
2. 1-flexible "child safe" indicator (a plastic strap used to bundle wires

Note: The wire bundle strap may be obtained from the Phone Company, or someone who works with wires (such as an instructional media repair person, electrician, or T.V. repair person)

The motor and batteries seen in Figures 24,26, and 27 were donated by a bakery warehouse. They had been used in an advertising campaign to operate an animated display of a Hostess cupcake revolving over the bread display. The motors and battery packs are very easy to get if you ask the manager for them and tell him/her what you intend to do with them.

Communication Board / Trainer
(Figures 28 and 29)

1. 1-light board (hardboard)
2. 1-plexiglass (same size as board number 1)
3. 2-rectangular pieces of rubber (hinges)



hinge attachment

GLOSSARY

GLOSSARY

CORONAL POSITION: That position which, seen from above, forms the shortest possible line between the student's ears, that is a line parallel to that formed by the forehead or shoulders.

ELECTROMAGNETISM: The magnetic force generated by the movement of electricity

GENERATIVE TEACHER: The hypothetical model of the "perfect" teacher. This teacher synthesizes information from related fields into his/her intervention with students. This generative teacher is also to generate learning experiences from any thing that happens in the classroom because he/she is so familiar with the training domains and training techniques.

INPUT DEVICE: Any means by which the operates a mode of output or reinforcement.

INTERFACE: As used herein it is an input device selected for use by a child for control of some output device because of its ease of operation within the responding ability of that student (noun). It is also used to refer to the activity of selecting the appropriate "switch" for the student (verb).

MICRO-PROCESSOR-CONTROLLED STIMULI: Those stimuli (output) produced by a device which is controlled by computer technology. These controlls may be in the form of contingency, rate, intensity, duratinn, etc. (or any other parameter of the student response).

OUTPUT DEVICE: Those machines or devices which have some product (light,

sound, vibration, air pressure, ets.) which may be reinforcing to the student.

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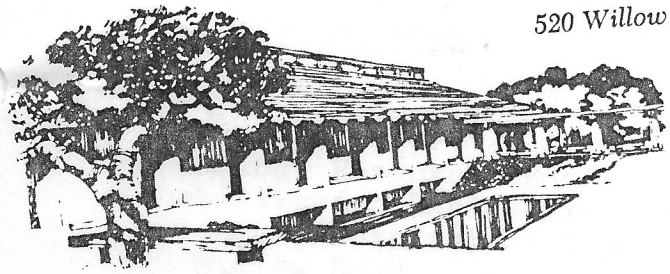

September 8, 1982

Chris Wethered
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Rehabilitation Engineering Center
1248 La Paloma
Memphis, TN

Dear Sirs:

The Children's Hospital at Stanford, Rehabilitation Engineering Center is establishing a new Technology Resource Center. We are currently developing a basic library of information that will be relevant to our clients. We would like to order the following materials from you for our library:

The Use of Current Technology in the Design and Construction of Simple Inexpensive Teacher Made Response-Contingent Educational Materials for the Severely and Profoundly Handicapped Population.

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